MT-440 -AC

MAINTENANCE MANUAL

A GUIDE FOR PERFORMING MAINTENANCE AND REPAIRS ON MT-440

SERIAL NUMBER FOR MT-440 : 122 00 94 AND UP
SERIAL NUMBER FOR MT-440N : 123 60 21 AND UP

UPDATED 05.11.2024
DESIGNED BY MOTREC INTERNATIONAL

MOTREC INTERNATIONAL INC.

5 YEAR LIMITED WARRANTY

FOR VEHICLES PRODUCED AFTER NOVEMBER 1ST, 2024

5-YEAR LIMITED WARRANTY ON AC-POWERED PRODUCTS, STOCK CHASERS AND TRAILERS

1-YEAR LIMITED WARRANTY ON DC OR IC POWERED PRODUCTS AND OTHER MOTREC PRODUCTS

Motrec warrants to the original purchaser that its products are free from defects in parts and workmanship.

STARTING DATE OF WARRANTY. The present terms and conditions of the Motrec Limited Warranty apply to new Motrec products only and do not replace any pre-existing warranty. The warranty period is effective from the date the purchaser receives the product, provided it is registered within ninety (90) days of reception and in conformity with Motrec's registration process.

REGISTRATION. IMPORTANT: AS A PURCHASER OF A MOTREC PRODUCT, IT IS IMPORTANT THAT YOUR PRODUCT BE REGISTERED UNDER YOUR NAME AS REQUIRED BY MOTREC'S PRODUCT REGISTRATION PROCEDURE. PLEASE ASK YOUR MOTREC DEALER TO REGISTER YOUR PRODUCT. MOTREC'S LIMITED WARRANTY WILL BECOME EFFECTIVE AT THE TIME OF PRODUCT REGISTRATION. IF YOU DO NOT REGISTER YOUR PRODUCT, THE STARTING DATE OF YOUR MOTREC LIMITED WARRANTY WILL TAKE EFFECT ON THE DATE THE PRODUCT WAS DELIVERED TO YOUR MOTREC DEALER. IF YOU PURCHASED THE PRODUCT DIRECTLY FROM MOTREC AND NOT FROM A MOTREC DEALER, MOTREC HAS AUTOMATICALLY REGISTERED YOUR PRODUCT.

DEFECTS. Subject to the terms and conditions described below, parts, components, or accessories installed on the product by Motrec that fail under normal usage within the warranty period, and that are proven to be defective, will be repaired or replaced without charge for parts or labor unless stated otherwise herein. This is Motrec's sole liability under this Warranty. Motrec reserves the right to require that all parts or components claimed to be defective be returned for inspection and verification of defect. The purchaser is responsible for any and all shipping fees of any and all parts or components that it alleges to be defective.

WARRANTY SERVICES. All warranty services must be rendered by authorized Motrec distributors and approved in writing by Motrec prior to initiating any repairs or adjustments. All approved warranty services will be paid for based on standard rates established by Motrec. Rather than replace or repair parts or components, Motrec may, at its discretion, replace the product or refund a prorated amount of its purchase price (based on service time, wear and tear) upon return of the defective product.

AUTHORIZATION PROCESS. No product shall be returned to Motrec without its prior authorization. All warranty claims must be disclosed to Motrec or its authorized distributor as soon as the purchaser is aware of a suspected defect or any event susceptible to give rise to a claim under the Motrec Limited Warranty. All claims must be processed through an authorized Motrec distributor using the warranty claim procedure approved by Motrec.

THE ABOVE TERMS AND CONDITIONS REPRESENT THE ONLY REPRESENTATIONS MADE BY MOTREC IN RELATION TO ITS PRODUCTS. MOTREC DOES NOT PROVIDE ANY OTHER PARTICULAR WARRANTY TO THE USER OF ITS PRODUCTS. MOTREC DOES NOT MAKE ANY EXPRESS OR IMPLIED WARRANTIES OR REPRESENTATION WITH RESPECT TO ANY RESULT, PERFORMANCE OR DURABILITY EXPECTED FROM THE USE OF ANY OF ITS PRODUCTS. MOTREC EXCLUDES AND DECLINES ANY OTHER WARRANTY OF SUITABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE WOULD THEY BE PROVIDED BY LAW, BY CONTRACT OR OTHERWISE.

PRODUCT MODIFICATIONS ARE PROHIBITED. Motrec prohibits and disclaims any and all liability for any modification made to the product, including but not limited to, modifications that are susceptible to alter the weight distribution and stability of the product, increase its speed or affect its safety. Such modifications can cause serious personal injury or property damage for which Motrec disclaims and excludes any and all responsibility. It is the purchaser's responsibility to ensure that any technicians servicing the product are properly trained as required by OSHA (Occupational Safety and Health Administration: https://www.osha.gov) and ANSI-B56 (American National Standards Institute: https://webstore.ansi.org/default.aspx). Service technicians shall read, understand and follow the instructions in the Motrec Owner's Manual before servicing the product. Only qualified and authorized personnel shall be permitted to maintain, repair, adjust and inspect the product.

TRAINING. It is the purchaser's responsibility to ensure that the driver or any person operating, using, maintaining or handling the product (or its accessories) is properly trained and instructed on the product's safety features and operation, including its stability. Operators shall read, understand and follow the safety and operating instructions in the Motrec Owner's Manual before driving the vehicle. Operators shall not be permitted to operate the product unless a complete and adequate training has been provided by the purchaser. Driving an electrical vehicle constitutes a hazard. The driver is responsible for the control of the product while driving and must always evaluate all unusual or particular situations that he or she may encounter while driving. The driver assumes the inherent hazards related to this activity. Motrec products are designed for off-road use only.

MOTREC INTERNATIONAL INC.
5 YEAR LIMITED WARRANTY

FOR VEHICLES PRODUCED AFTER NOVEMBER 1ST, 2024

EXCLUSION OF LIABILITY. Motrec disclaims any liability for incidental or consequential damages, including, but not limited to, personal injury or property damage arising from misuse of the product, lack of maintenance or any defect in the vehicle.

UNDER NO CIRCUMSTANCE WILL MOTREC BE LIABLE FOR ANY DAMAGE, WHETHER DIRECT, INDIRECT OR OTHERWISE, RESULTING FROM THE USE OF ITS PRODUCTS, EVEN IF MOTREC OR ONE OF ITS REPRESENTATIVES WAS AWARE OF THE POSSIBILITY OF SUCH DAMAGE. ANY LIABILITY FOR LATENT DEFECT IS LIMITED TO THE PRICE OF THE PRODUCT.

1. Definitions

"Product": the complete electrical vehicle manufactured and/or assembled by Motrec, including its parts, components and accessories installed by Motrec.

"Purchaser": The party in whose name the product is originally registered at the time of purchase pursuant to the product registration procedure maintained by Motrec at that time, either: (a) the party to whom Motrec sold the product, if that party purchased the product for its own use, or (b) the customer of a Motrec dealer, who bought the product directly from such dealer.

2. Warranty Period

Your Motrec product is covered by the Motrec Limited Warranty for a period of five (5) years or 5,000 hours of use, whichever comes first. This period of three (3) years starts on the date the product is registered, as mentioned hereinabove. This coverage does not apply to wearable parts, normal use or abusive usage of the product.

3. Warranty Registration

The warranty registration must be completed within ninety (90) days of purchase of the product. If registration is not completed within this time, the warranty will begin on the date the product was delivered. If you purchased the product from a Motrec dealer, please make sure the dealer has completed the registration. If you purchased the product directly from Motrec, Motrec has automatically registered your purchase.

4. Maintenance:

Motrec requires that scheduled maintenance be performed at the times shown in the Owner's Manual. If this scheduled maintenance is not done and the product fails as a result of a failure to properly maintain it, repairs will not be covered under any warranty.

5. Warranty will be void if:

- The product has been modified in any manner not approved in writing by Motrec.
- The product has been overloaded beyond its rated capacity.
- The product's maximum speed has been increased.
- The product's motor controller parameters have been tampered without Motrec's authorization.
- The product has been used abusively
  (including, but not limited to improper use; twisted, bent, misaligned front or rear axles; any signs of abusive use).
- The product has been involved in an accident.
- The product has been transferred to a second owner without Motrec's authorization.
- The product has been used in extreme environments (including, but not limited to freezes, excessive moisture areas, corrosive environments, etc.).
- The product has had its serial number modified or altered.
- The product was not maintained as specified in the Motrec Owner's Manual.

6. The following items are not covered by the Motrec limited warranty:

- Batteries, charger, wheels
- Wearable parts (fuses, tires, wheel bearings, seals, brake pads and shoes)
- Wear and Tear resulting from normal use
- Adjustments, including field set-up
- Damage or defects caused by using non-Motrec parts, components, or accessories
- Shipping damage caused by freight carrier
- Shipping fees for warranty parts
- Travel fees for technical support and repair

FOREWORD

WELCOME

MOTREC International Inc. has built a rock-solid reputation as a world-class designer and manufacturer of electric industrial vehicles for the horizontal transportation of goods and people. We innovated, reimagined, engineered, and drove ourselves tirelessly to this preeminent position.
We also consistently exceeded customer expectations, which is why legions of satisfied customers worldwide have been driving MOTREC since 1988.

INTELLECTUAL PROPERTY

 All information in this publication is based on information available at the time of approval for publication. MOTREC reserves the right to make changes without notice or without incurring any obligation.

MOTREC INFORMATION

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ABOUT THE MANUAL

Make sure to read the manual in its entirety before operating or servicing the vehicle. Keep the manual close for reference when necessary. Do not discard the manual. If the vehicle is sold or transferred, provide this manual with it.
This manual is based on the latest available information at the time of publication.

MOTREC®

“AYONE CAN WORK WE PERFORM THAT’S MOTREC ”

-Motrec Tagline

CONTENTS

1. PREFACE

1.1. INTRODUCTION

Read Before Operating

Make sure to read and understand the content of this Maintenance Manual before operating or attempting maintenance on the vehicle. The present document provides a vehicle overview and safety information for the operator, passengers, and others, as well as a detailed list of the maintenance to be executed over the lifespan of the vehicle.

Keep this manual for future reference. If the vehicle is sold or transferred, provide this manual with the vehicle.

A plan for maintenance instructions is included in this document. These instructions are intended for an MT-440 experienced technician to accelerate the maintenance process. The instructions should not be used by any untrained or inexperienced personnel.

The MT-440

The MT-440 represents the latest generation of tow tractors. Beneath its sleek, compact design lies a highly efficient AC direct-drive powertrain that provides ample power to tow 20,000-pound loads over long distances, along with an oversized industrial battery to extend operating time. Key features such as a tight turning radius, rear battery placement, and shock-absorbing suspension ensure outstanding maneuverability, stability, and comfort. This durable, low-maintenance two-seater is engineered for longevity from its bolt-on bumper to bumper.

Modular Design

The MT-440 like other MOTREC vehicles, can quickly adapt to new work requirements. Its modular design allows for a quick change of configurations based on the task at hand. Predefined packages and options are available to fulfill standard needs, as well as a customization process to accommodate specific customer needs.

Refer to our website www.motrec.com for more details about the configurations.

1.2. ACRONYMS AND ABBREVIATIONS

°C : Celsius
°F : Fahrenheit
ANSI : American National Standards Institute
AUX : Auxiliary
EMB : Electromagnetic Brake
ft : Feet
A : Amperes
HD : Heavy Duty
HP : Horsepower
HPD : High Pedal Disable
Hz : Hertz
ITSDF :Industrial Truck Standards Development Foundation
kg : Kilogram
km/h : Kilometer per Hour
kW : Kilowatt
kWh : Kilowatt-Hour
lb : Pounds (Weight)
lbf : Pound (Force)
LD : Low Duty
LED : Light Emitting Diode
m : Meter
mL : Milliliter
mm : Millimeter
N/A : Not Applicable
N·m : Newton Meter
OSHA :Occupational Safety and Health Administration
P/N : Part Number
PMC : Power Motor Controller
PWM : Pulse Width Modulation
SOC : State of Charge
SRO : Static Return To Off
VAC/AC : Volts Alternating Current / Alternating Current
VDC/DC : Volts Direct Current / Direct Current

2. SAFETY INFORMATION

2.1 SAFETY SIGNAL WORDS AND SYMBOLS

Before operating the vehicle and reading the manual, it is important to familiarize yourself with the signal words and symbols that appear throughout the manual and on the vehicle. Understanding their meanings will help ensure safe and effective use of the vehicle.

WARNING

WARNING INDICATES A HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN SERIOUS INJURIES.

CAUTION

CAUTION INDICATES A SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN DAMAGE TO SOME EQUIPMENT.

NOTICE : Notice is used to address practices not related to personal injury.

2.2 SAFETY DECALS AND LABELS

WARNING

DECALS, MARKINGS, OR STICKERS MUST REMAIN UNALTERED AND READABLE AT ALL TIMES. REPLACE ANY UNREADABLE DECALS, MARKINGS OR STICKERS. FAILURE TO COMPLY COULD CAUSE SERIOUS INJURIES.

The vehicle contains numerous safety decals that provide essential information for both the operator and technicians. To view a complete list of all the decals, please refer to the **PARTS CATALOG (MPV)**.

3. VEHICULE OVERVIEW

3.1. SPECIFICATIONS AND CONFIGURATIONS

The MT-440 specifications and configurations can vary depending on the specific model and year of the MT-440. For more information and the most up-to-date details, it is best to consult with Motrec directly or refer to our website www.motrec.com.

EQUIPMENT COMPARTMENTS:

NOTE 1 : The knobs compartment houses the EMB service knobs. When not inserted into the EMB (to allow vehicle movement), the EMB service knobs should always be stored in this compartment, screwed to the back wall.

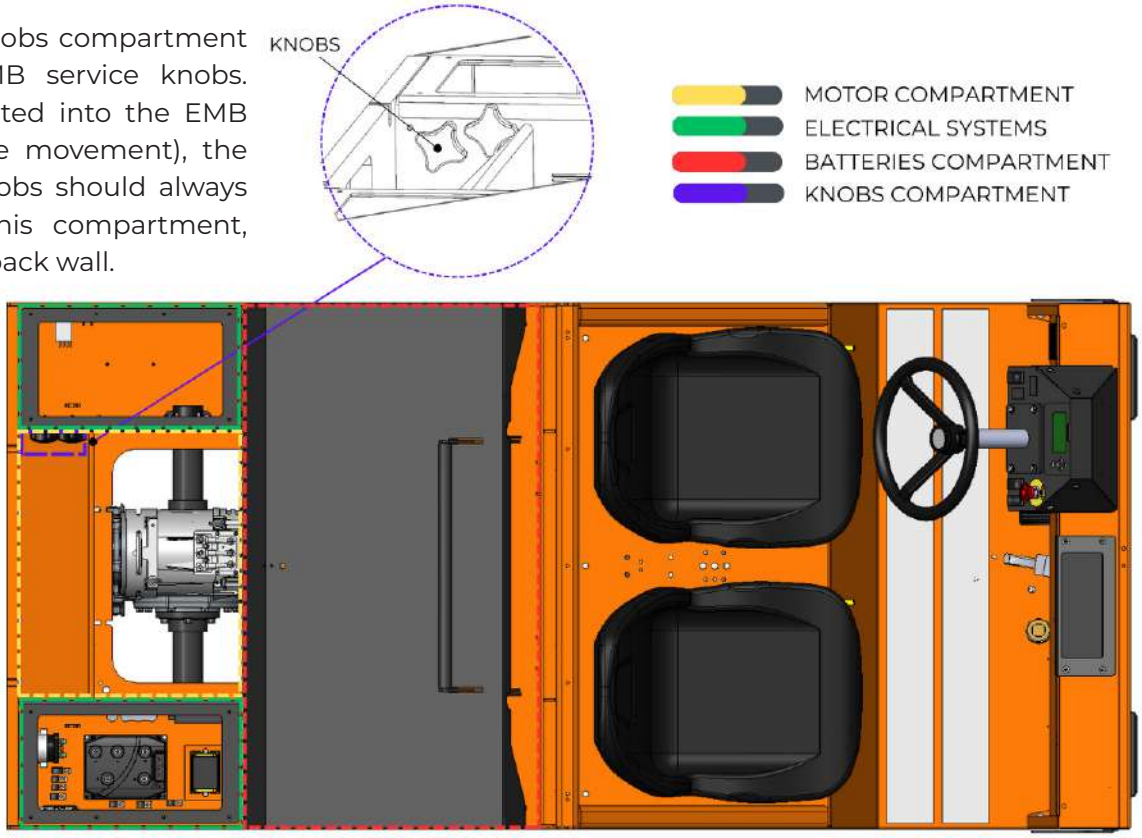


Figure 1. Equipment Compartments MT-440.

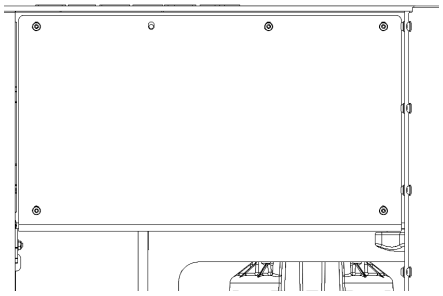


Figure 2. Control Cover Plate.

NOTE 2 : To access the electrical components, both the right and left control cover plates at the back must be removed (see Figure 2).

NOTE 3 : Batteries must be inserted into the designated battery compartment (not shown above in the figure). The client is responsible for selecting which batteries to place in this compartment.

The MT-440N (Narrow) is a version of the MT-440 that shares the same appearance as the standard model, with the primary differences lying in the differential, vehicle width, and seating configuration. While the standard MT-440 uses a Schafer differential, the MT-440N is equipped with a Benevelli differential. Additionally, the MT-440N is a narrower, one-seated version, whereas the MT-440 has a two-seater design. It's essential to note that all maintenance steps are identical for both models, with the exception of differential-specific maintenance. This ensures streamlined servicing procedures while accounting for the unique requirements of each differential type.

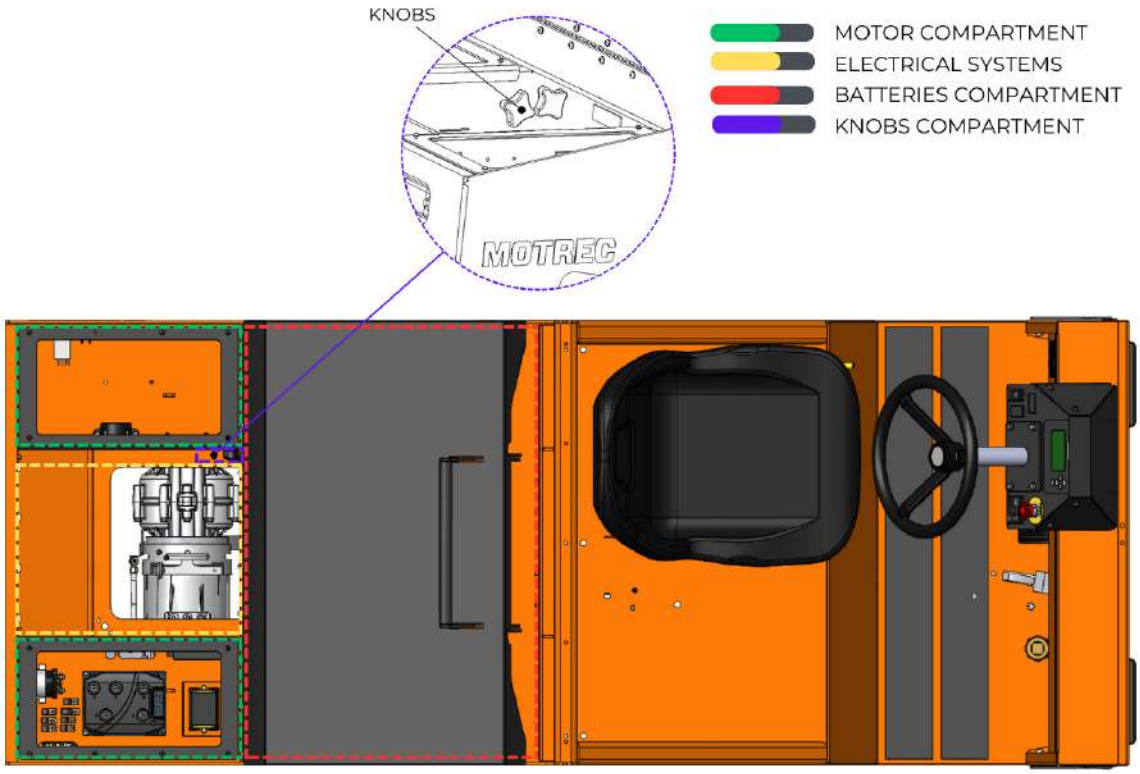


Figure 3. Equipment Compartments MT-440N (Narrow).

Figure 4. a. Front View of MT-440N.

Figure 4. b. Side View of MT-440N.

Figure 4. a. Rear View of MT-440N.

3.2 BATTERIES COMPARTMENT

CAUTION

DO NOT MODIFY THE BATTERY VOLTAGE OR REPLACE THE BATTERY CHARGER. THE INSTALLED BATTERY CHARGER IS SPECIFIC TO BATTERY VOLTAGE. FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

The vehicle can only be powered by **Flooded (lead-acid)** batterries.

Batteries Compartment :

To access the battery compartment, lift the cover using the handle. This standard battery compartment is devoid of any mechanical components, allowing for easy removal of the batteries by lifting them out. An SB-350 blue connector kit is installed in the compartment to facilitate easy connection and disconnection of the batteries. Only the **48V** total battery voltage option is currently offered.

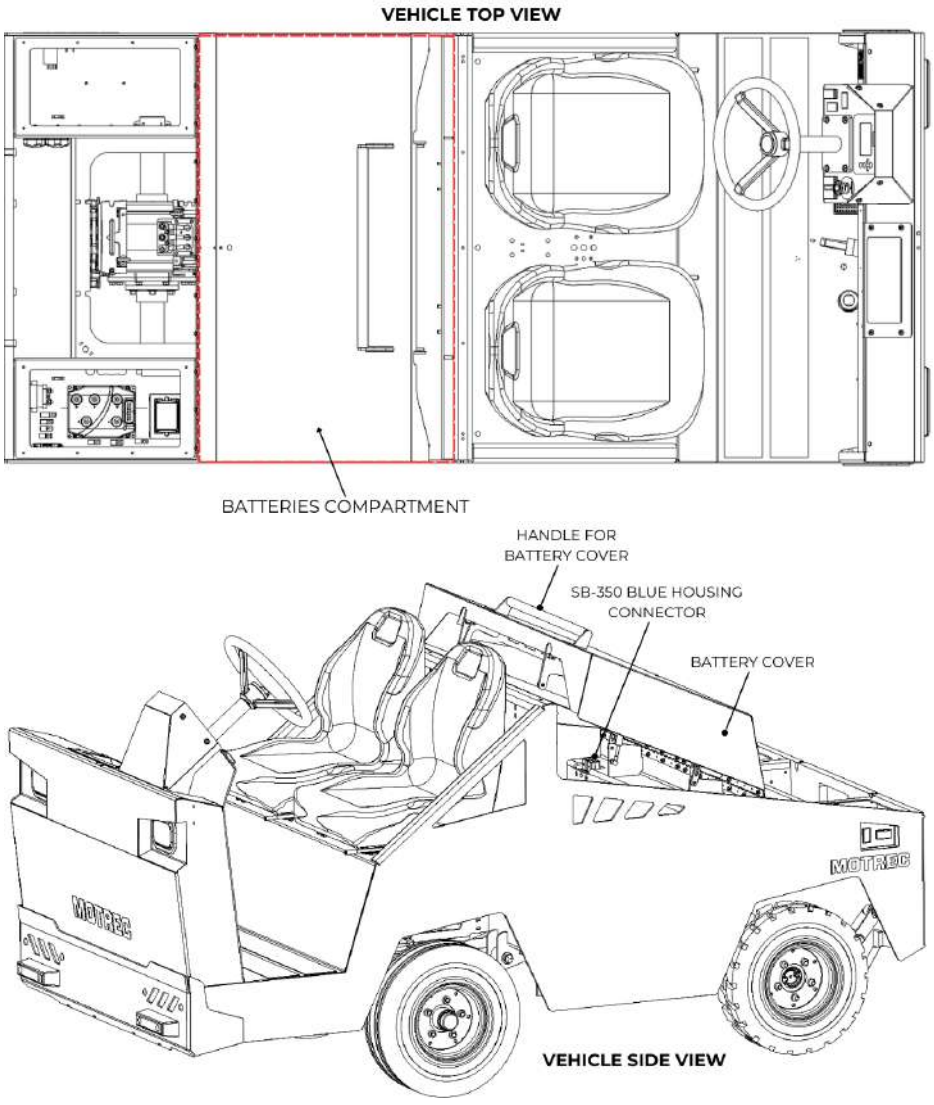


Figure 5. Batteries Compartment.

3.3 ELECTRICAL SYSTEMS

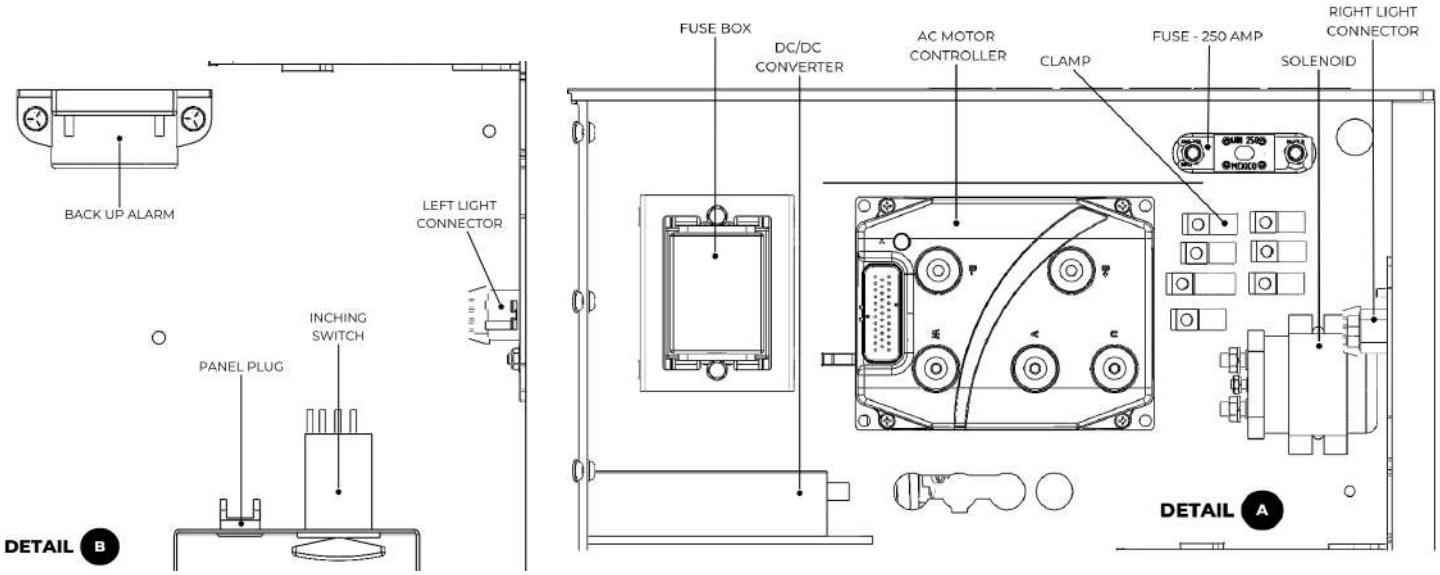
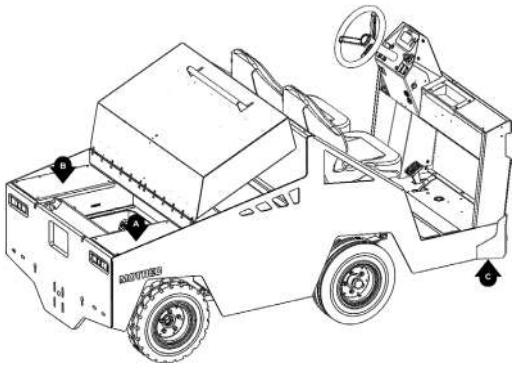


Figure 6. a. Electrical System Compartments Details A and B.



HORN PLACEMENT

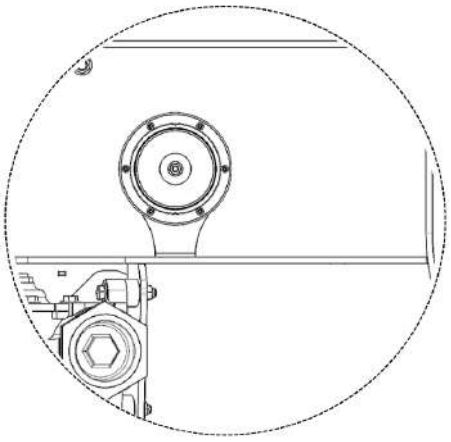


Figure 6. b. Electrical System Compartments Detail C.

This compartment receives the energy from the battery compartment and redistributes it to the different electrical systems of the vehicle. The energy systems can be divided into two categories:

-The Main Energy : which uses the full battery voltage to power various systems. The voltage is also converted to AC voltage by the AC motor controller to power the AC motor.

- The Auxiliary Energy : which powers the different accessories of the vehicle (backup alarm, horn, lights, strobe, etc.) (12V).

For connection details, refer to the vehicle's electrical schematic in section Annexes.

NOTE: The vehicle's frame is not to be considered as a ground. No component is connected to the frame as a closed-circuit loop.

3.3.1 MAIN ENERGY

The main energy system encompasses all the elements responsible for the vehicle's movement, such as the AC motor, accelerator, seat switch, and movement alarms, among others.

The energy flow originates from the batteries and passes through the main fuse and contactor before reaching the AC motor controller. This controller harnesses the DC voltage to supply power to different components while also converting the DC voltage to AC to drive the AC motor.

NOTE : The wiring remains the same, but the component placement may vary from one vehicle model to another.

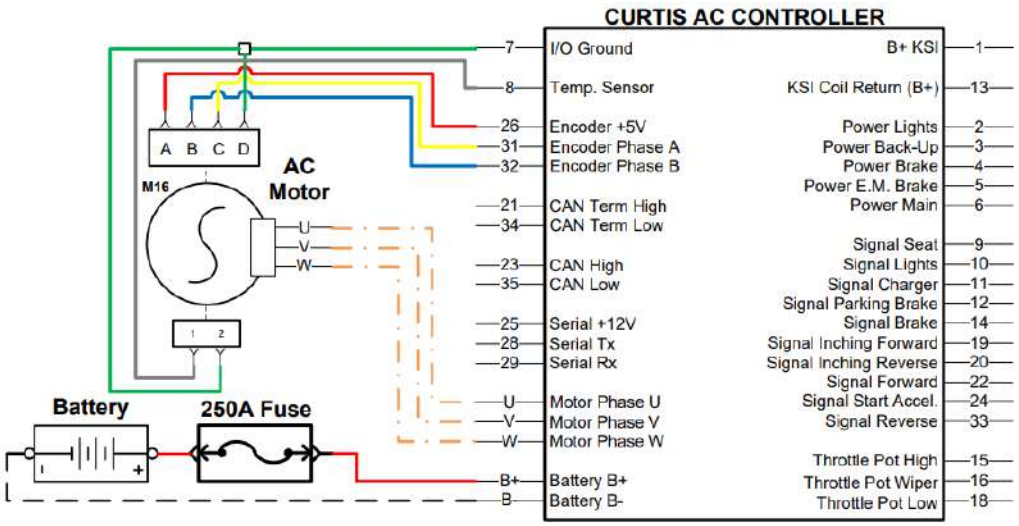


Figure 7. Main Energy Electrical connection (Annexe 5).

3.3.2 AUXILIARY ENERGY

To power the auxiliary systems of the vehicle, including the backup alarm, lights, horn, and others. The DC-DC converter utilizes the 80 VDC battery voltage and converts it to an output of 12 VDC / 13.4 VDC. This voltage is then directed through the auxiliary fuse box and distributed to the vehicle's accessories.

NOTE : The wiring remains the same, but the component placement may vary from one vehicle model to another.

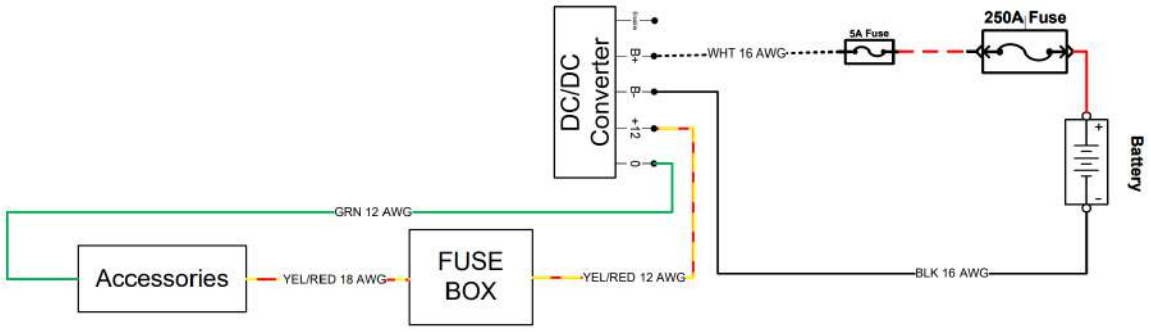


Figure 8. Auxiliary Energy Electrical connection (Annexe 5).

3.4 MOTORS AND REAR AXLE

3.4.1 AC MOTORS

The MT-440 is equipped with a brushless AC direct drive motor that enables forward and backward propulsion of the vehicle. This motor is powered by a 3-phase current supplied by the AC motor controller. For more detailed information, please refer to section 3.3.1 MAIN ENERGY. Additionally, the motor features regenerative braking functionality, which enables the vehicle to decelerate without relying solely on friction brakes and allows a portion of the deceleration energy to be returned to charge the batteries.

Depending on the vehicle's operating environment, the AC motor is available in two different casings.

A. **ENCOLSED :** Designed for use in environments with high sanitation requirements or excessive dust, this motor features a sealed casing that effectively prevents sparks from escaping and debris from entering. Primarily utilized in EE-rated applications, it ensures optimal performance and safety.

B. **FAN COOLED :** This motor is specifically designed to operate effectively in diverse environments. It features an integrated fan on its rotor, which efficiently draws air through the venting holes to enhance the motor's cooling capacity.

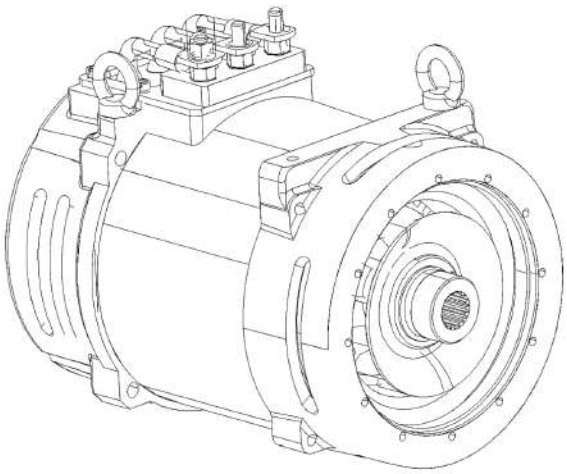


Figure 9. a. AC Motor Side View.

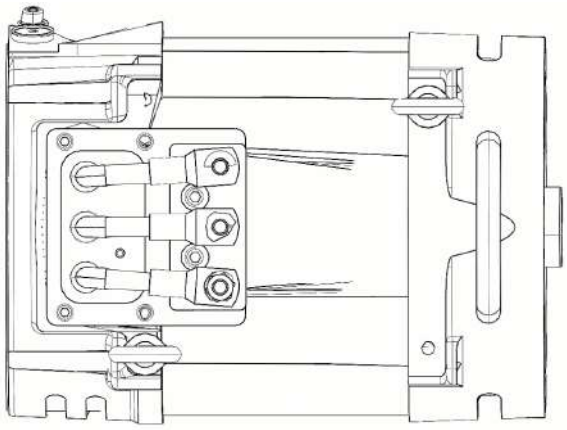


Figure 9. b. AC Motor Top View.

NOTE : The MT-440 and MT-440N models are equipped with the same AC motor, ensuring consistent power and performance across both versions.

3.4.2 REGENERATIVE BRAKING

The regenerative braking feature of the AC motor is specific to the drive wheels of the vehicle. It utilizes the motor's electrical resistance to assist in decelerating the vehicle while simultaneously recharging the batteries. By adjusting the amount of electrical current flowing through the motor, the behavior of regenerative braking can be modified.

There are two distinct states of regenerative braking:

1. Coasting: Regenerative braking is engaged when the accelerator pedal is released, allowing the vehicle to slow down naturally. During this state, the motor acts as a resistance, converting the vehicle's kinetic energy into electrical energy, which is then fed back into the batteries.
2. Electrical Braking Assistance: Regenerative braking is activated when the brake pedal is depressed. In this state, regenerative braking provides additional assistance to the mechanical brakes, enhancing the overall braking performance of the vehicle. The motor's resistance aids in slowing down the vehicle while simultaneously generating electricity to recharge the batteries.

⚠ WARNING

ALL VEHICLE OPERATORS MUST BE NOTIFIED IF THE REGENERATIVE BRAKING'S DECELERATION LEVEL IS MODIFIED. FAILURE TO COMPLY CAN CAUSE INJURY OR DAMAGE TO THE EQUIPMENT.

Although MOTREC optimizes this feature to deliver significant advantages such as enhanced energy efficiency, prolonged battery lifespan, minimized mechanical brake wear, and the ability to capture and repurpose dissipated heat energy, it may prove overly aggressive for specific applications. Fortunately, the level of deceleration can be customized through the display screen. For detailed instructions on adjusting the regenerative braking settings, please consult the TECHNICAL TRAINING section available on the dealer portal.

3.4.3 ELECTROMAGNETIC BRAKE (EMB)

The MT-440/MT-440N electric vehicles are equipped with an electromagnetic brake (EMB) that provides reliable and efficient braking performance. The electromagnetic brake is designed to assist in place when necessary.

The electromagnetic brake is in a Normally Applied state and is electrically released during operation. This means it requires current to be released and allow movement of the vehicle. This safety feature automatically stops the vehicle in the event of loss of power, therefore removing the need for a handbrake (parking brake).

The spring-applied brake keeps the vehicle stationary when it comes to a stop, or when the power is cut off. In situations where the vehicle is not powered and requires movement, it is necessary to insert the electromagnetic brake's service knobs.

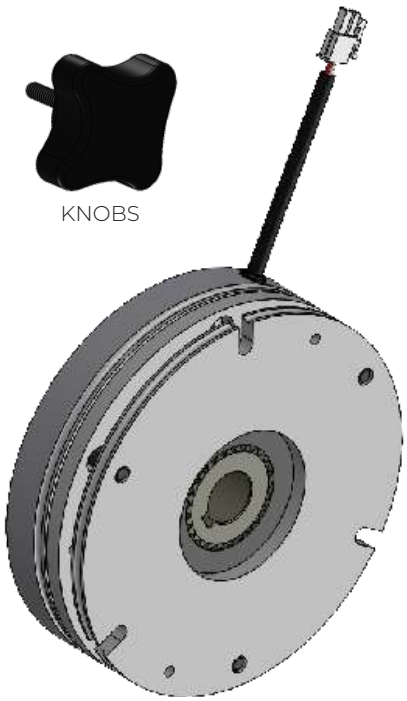


Figure 10. EMB Brake System.

3.5 BRAKE SYSTEM

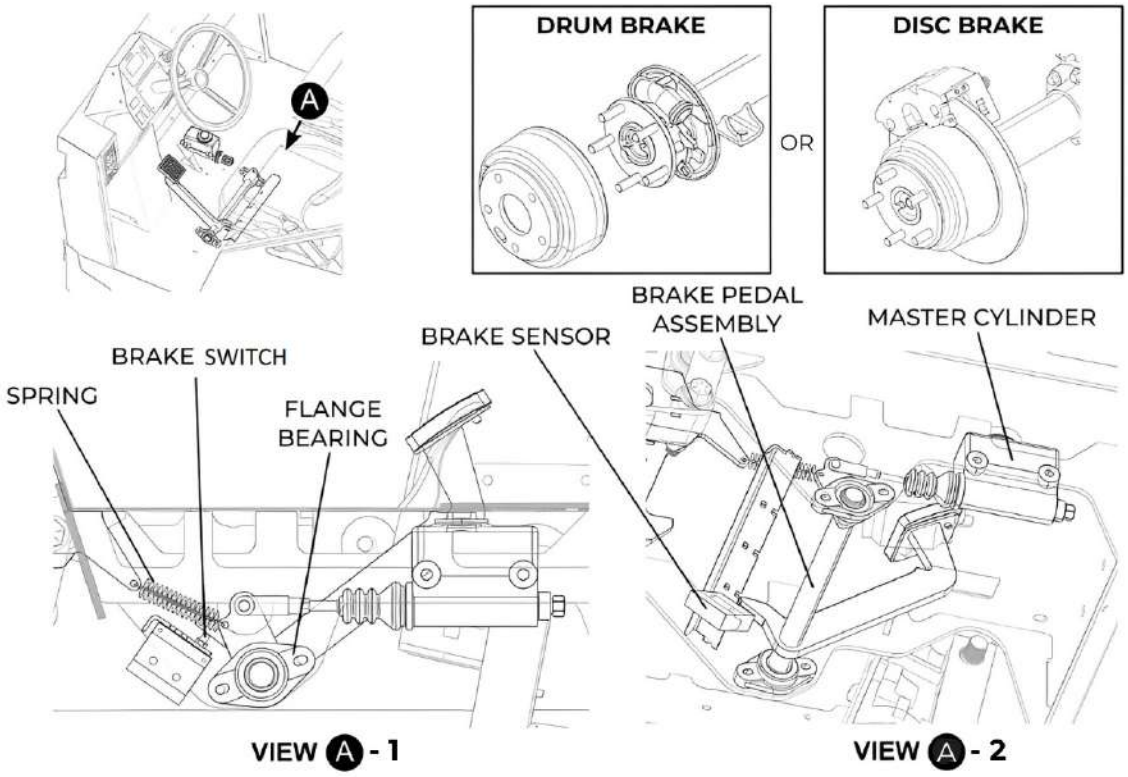


Figure 11. Brake System.

When the brake pedal is depressed, the assembly rotates around the flange bearings, pushing the push rod into the master cylinder, therefore creating a pressure into the brake conduits, and activating the brakes. When released, the spring pulls back the brake pedal which brings back the brake system to its original state.

When the accelerator pedal is released, the controller engages the regenerative braking in the “coasting” state. This slows down the vehicle using the electrical current produced by the rotating motor armature and charges the batteries. When the brake pedal is depressed, the controller engages the “braking” state of regenerative braking, making the vehicle slow down even more. This maximizes the amount of energy recovered from the deceleration and minimizes brake wear.

NOTE 1 : Refer to *TECHNICAL TRAINING* on the dealer portal for more information on regenerative braking and its settings.

NOTE 2 : A brake sensor is located near the brake pedal assembly. The proximity of the brake switch allows for the direct mechanical interaction required to detect the engagement or disengagement of the brakes. When the brakes are not engaged, the switch is in its default position, indicating that the brakes are not activated. As soon as the brake pedal is pressed, it activates the brake lights and signaling to other drivers that the vehicle is slowing down, moving backwards, or coming to a stop.

3.6 STEERING SYSTEM

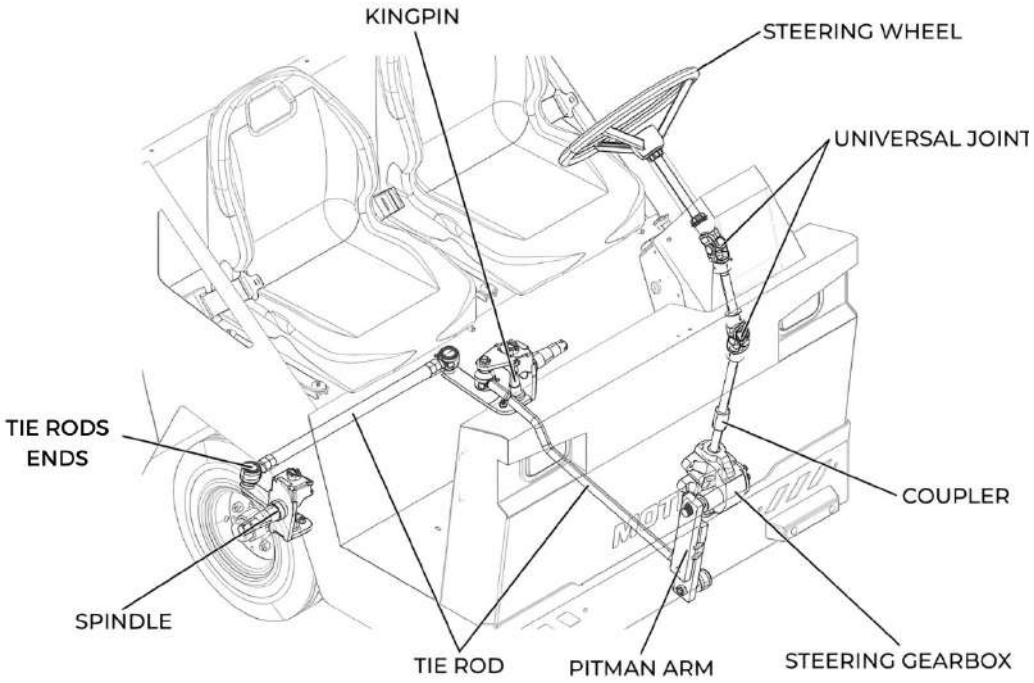


Figure 12. Steering System.

The vehicle is steered via a conventional two front wheels steering system. When the driver turns the steering wheel, the motion is transmitted to the steering gearbox through two universal joints. The steering gearbox amplifies the rotational movement to pivot the pitman arm, which, in turn, transfers the motion to the wheels' spindles via the tie rods.

The standard steering system is entirely mechanical and does not incorporate any electrical or hydraulic elements. However, certain models offer the option to install a hydraulic power steering system.

3.7 SUSPENSIONS

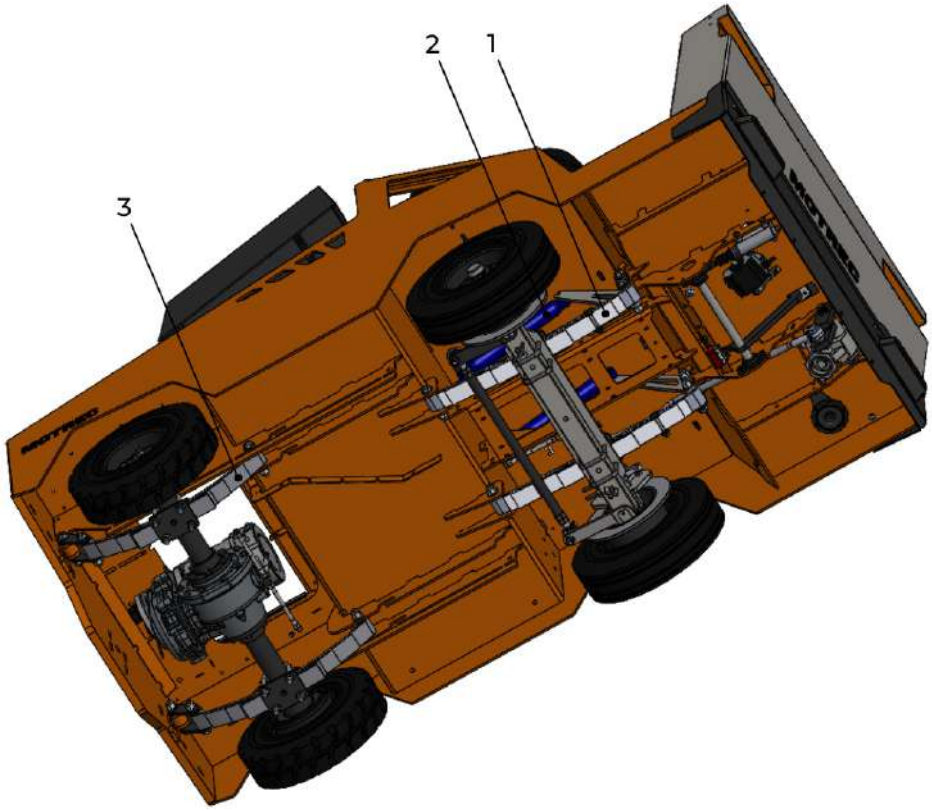


Figure 13. Suspension System.

The vehicle's suspension system is thoughtfully balanced, featuring two leaf springs (1) and shock absorbers (2) at the front and two additional leaf springs (3) at the rear. In the front, the leaf springs provide flexibility and robust support to the axle, ensuring even weight distribution and effective absorption of surface irregularities. The rear leaf springs, positioned to support the motor and differential, provide additional stability and help manage the extra weight in the rear, ensuring a smooth ride and balanced load distribution. The front shock absorbers work alongside the leaf springs to efficiently control and dampen suspension movement, minimizing vibrations and jolts for enhanced ride comfort.

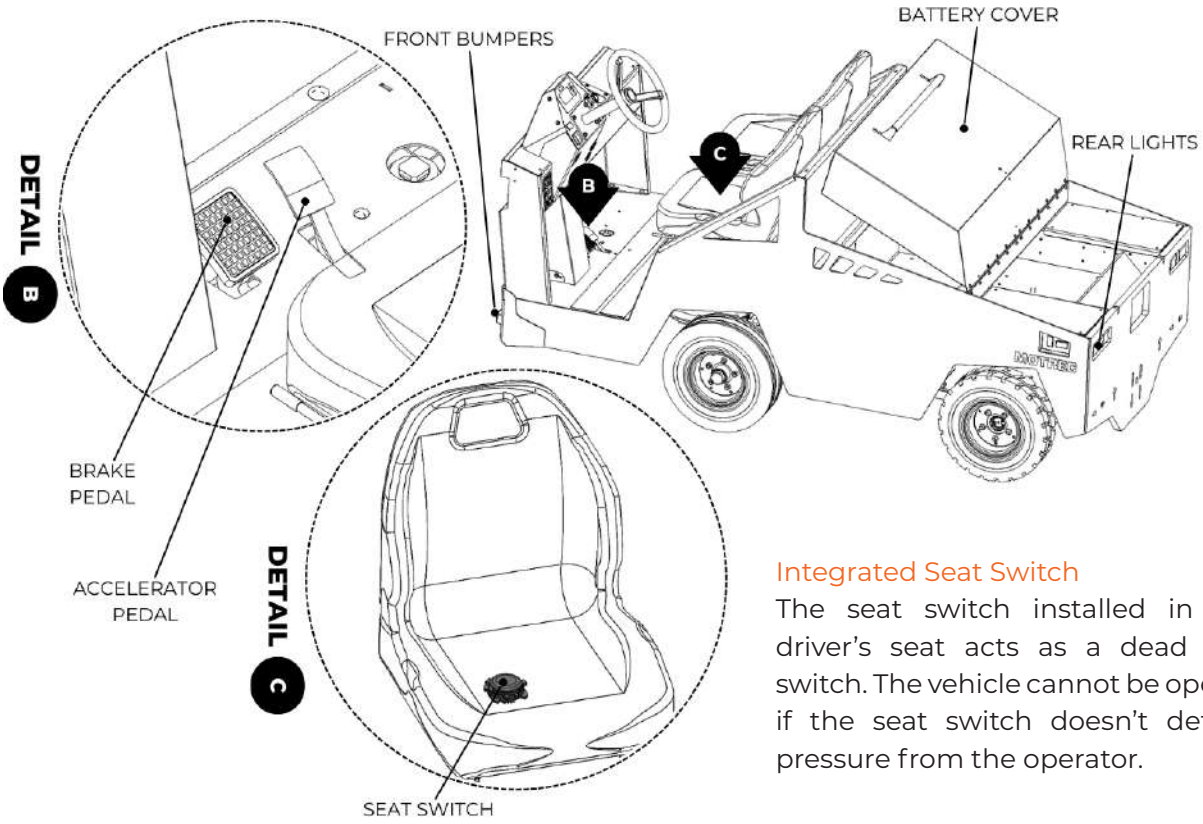
This combination results in a well-rounded suspension system that excels in stability, comfort, and performance across diverse driving conditions.

3.8 GENERAL COMPONENTS

Electrical Cables

The electrical cables are carefully guided and routed beneath the vehicle. They follow the path provided by the frame, which acts as a designated cable tray. This routing ensures that the cables are neatly organized and protected from potential hazards or obstructions. Their ultimate destination is the console, where they connect to various electrical components, allowing for seamless operation and control within the vehicle.

Figure 14. a. General Components (Detail A).



Integrated Seat Switch

The seat switch installed in every driver's seat acts as a dead man's switch. The vehicle cannot be operated if the seat switch doesn't detect a pressure from the operator.

Figure 14. B. General Components (Details B and C).

3.9 CONSOLE

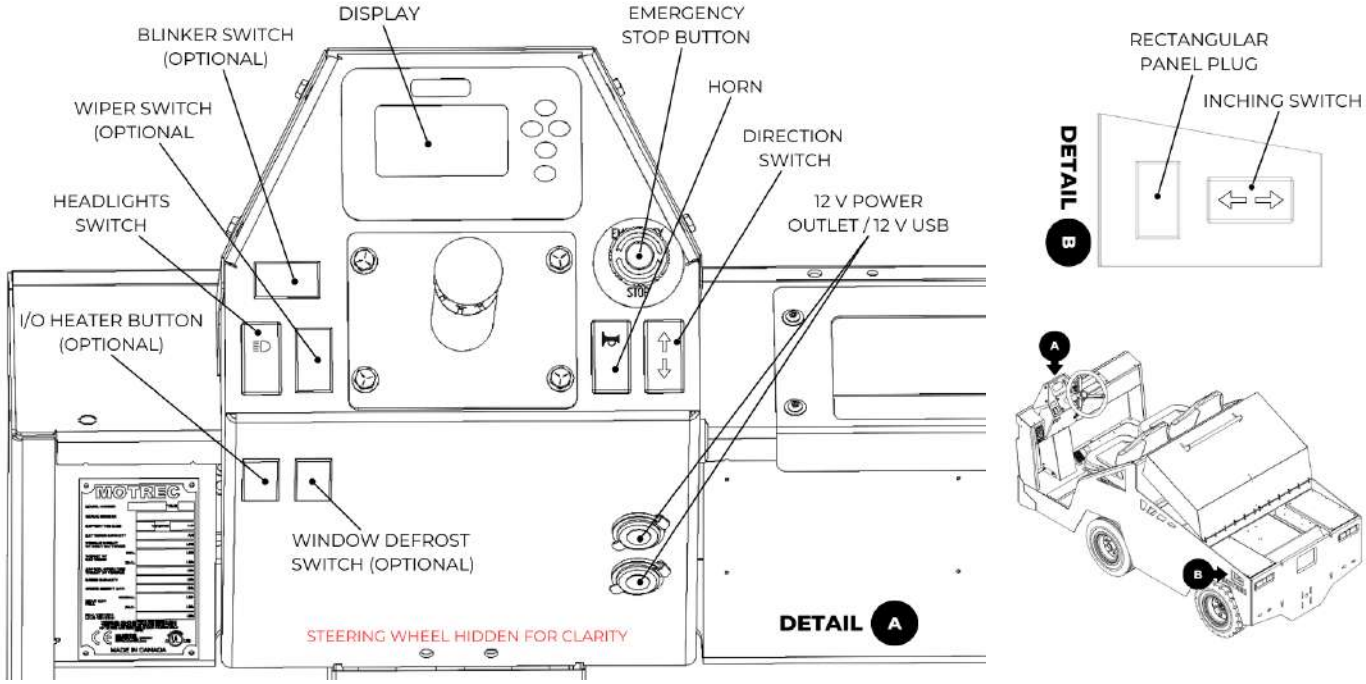


Figure 15. Console.

Direction Switch (Forward/Reverse)

This switch controls the motion direction of the vehicle:

- Pushing the top part sets the vehicle in forward drive.
- Putting the switch in the middle sets the vehicle in neutral.
- Pushing the bottom part sets the vehicle in reverse drive.

Key Switch

The key is used to engage or disengage the switch, allowing or preventing the flow of electricity or the operation of the associated device.

Display

It conveys information effectively and facilitate communication between the system and the user, providing a visual representation of data or content in a clear and understandable manner.

Emergency Stop Button

The emergency stop button, when present, should only be used in case of emergency.

CAUTION

DO NOT USE THE ENERGY STOP BUTTON TO TURN OFF THE VEHICLE. USE THE KEY SWITCH FOR NORMAL ON/OFF CONTROL. FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

3.9.1 DISPLAY

Parking Brake

This indicator lights up when the parking brake is engaged.

Headlights Indicator

Lights up when the headlights are ON.

Maintenance

This indicator lights up when the maintenance timer has reached its limit, or when one of the systems has encountered a problem and requires further investigation.

Direction Arrows (Forward/ Reverse)

These indicators light up depending on the drive toggle's position to inform the operator of the direction the vehicle will move.

Navigation Arrows

Theses buttons are to be used when navigating through the operator interface.

Drive Mode Indicator

Indicates the current selected drive mode between rabbit and turtle.

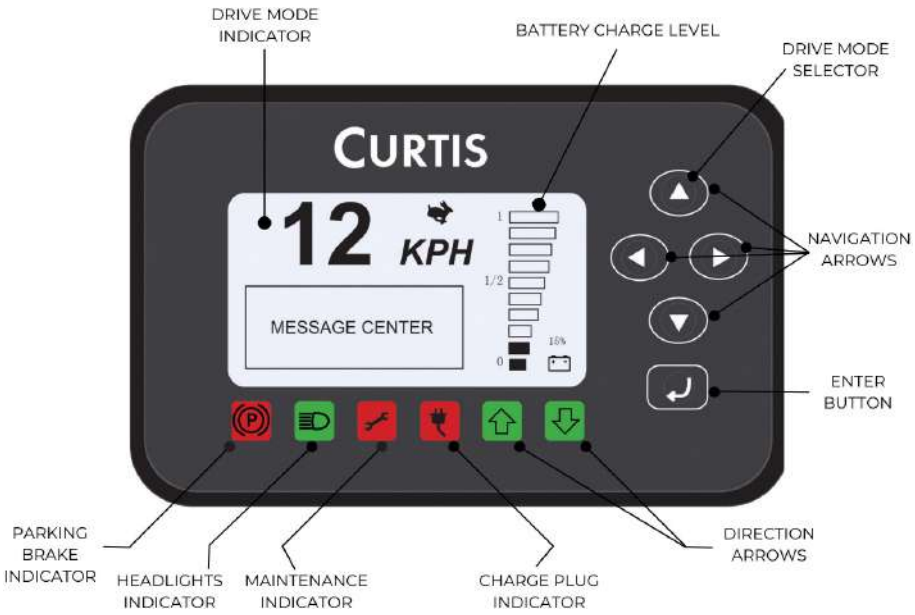


Figure 16. Display.

Enter Button

This button is to be used when selecting an option in the operator interface. When the button is held down, it initiates the opening of menus.

Drive Mode Selector

During operation, the up arrow is also used to change the drive mode between turtle and rabbit for a different vehicle speed.

Battery Charge Level

Indicates the state of charge of the batteries.

Vehicle Runtime

Indicates the total vehicle runtime. The engine runtime is only calculated while the vehicle is in motion and defines the interval of the preventive maintenance.
For more information, refer to section 4.2 PREVENTIVE MAINTENANCE (page 28).

3.9.2 OPERATOR INTERFACE

Login Credentials

In order to access and modify the vehicle settings through the driver console, specific passwords need to be entered based on the desired settings. For MOTREC settings, the password "**3050**" is required.

Four Pin Diagnostics Connector

To access an advanced operator interface, you can connect a Curtis handheld programmer to the four-pin diagnostics connector located at the right side of the console's kick panel. It's important to note that the display connector (refer to Figure 17) needs to be disconnected each time the handheld programmer is used.

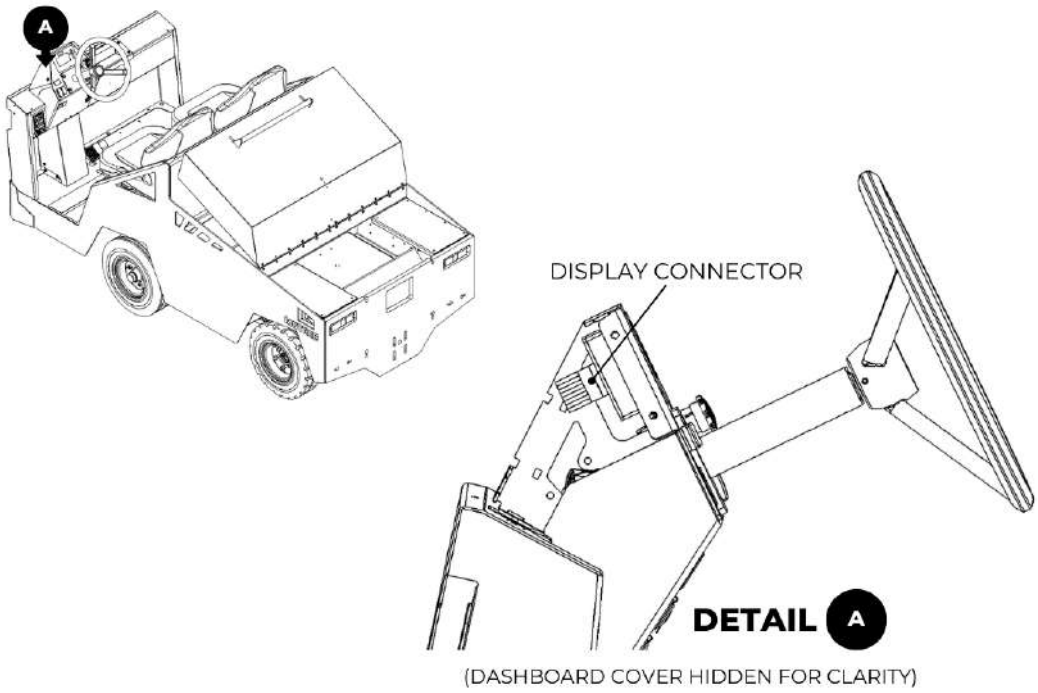


Figure 17. Display Connector.

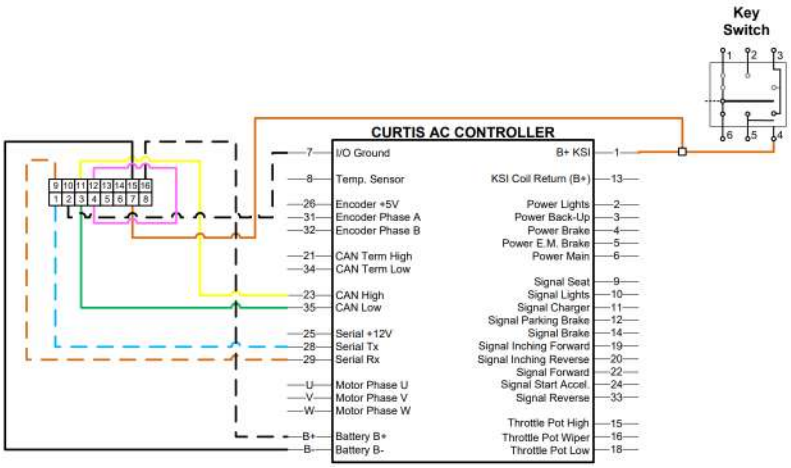


Figure 18. Display Connector Electrical connection (Annexe 5).

Vehicle Speed

WARNING

NOTIFY AFTER THE MAXIMUM VEHICLE SPEED HAS BEEN MODIFIED. FAILURE TO COMPLY CAN CAUSE ACCIDENTS AND DAMAGE TO THE VEHICLE.

Prior to changing the maximum vehicle speed, check that the speed modification is truly required by the operator and validate with MOTREC that the speed won't affect the integrity of the vehicle.

To modify the maximum speed:

1. Turn the ignition key to ON.
2. Hold the **Enter** button for 5 seconds.
3. Select **MOTREC Settings**.
4. Select Input Password.
5. Enter the password: **3050**.
6. Navigate as follows: Programmer → **Program** → **MOTREC Parameters** → **MOTREC Speed Limits (KMH)** → **KMH Max Speed Limits** → **Rabbit FWD Max Speed**.
7. Press the right arrow.
8. Adjust the speed value using the up/down arrows.
9. Press the left arrow to exit the value modification.
10. Select **Exit**.
11. Turn the ignition key to OFF.

3.9.3 ALARMS AND FAULTS

While operating the vehicle, the display screen may display warnings to alert the driver about vehicle-related events. Each MOTREC vehicle is equipped with a controller that relies on input signals, processes information, and generates output commands. In the event of a malfunction, the controller will generate a fault code to indicate that it has detected a situation that falls outside the specified parameters. These fault codes are stored in the controller's memory until they are cleared.

It is recommended to begin by reading the fault codes in order to diagnose any issue. This will provide valuable information about the nature of the problem.

For a comprehensive list of all the fault codes, please refer to the annexes located at the end of this document.

3.9.4 REAR LIGHT COLORS SIGNIFICATION

There are four available rear light colors in the vehicle, which are as follows: *white* is used for reversing, *pale red* (standard) indicates vehicle startup, the intensity of pale red increases under braking becomes *Intense Red*, and *orange* (if applicable) activates as a turn signal when available in the vehicle. These color signals are used to enhance safety and communication on the road.

4. MAINTENANCE

4.1 GENERAL INFORMATION

This section provides a general overview of the maintenance procedures for a standard MT-440 vehicle. While the images displayed may not match the exact product due to varying configurations and accessories, the maintenance steps outlined here are applicable to all MT-440 models as they cover the fundamental processes. If you have any maintenance-related questions specific to your product's features, please reach out to MOTREC for assistance.

Before undertaking any maintenance operations, except for daily and weekly preventive maintenance, it is recommended to remove any obstructing accessories installed on the deck. This will facilitate the necessary manipulations and ensure smoother maintenance procedures.

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS DISCONNECT THE CHARGER AND USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

WARNING

KEEP CLEAR FROM MOVING PARTS SUCH AS TIRES, SHEAVES, AND MOTOR. FAILURE TO COMPLY CAN CAUSE INJURIES.

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

CAUTION

ONLY QUALIFIED AND AUTHORIZED PERSONNEL ARE PERMITTED TO MAINTAIN, REPAIR, ADJUST, AND INSPECT THE VEHICLES AND THEIR BATTERIES. FAILURE TO COMPLY CAN LEAD TO DAMAGE TO THE EQUIPMENT.

CAUTION

USE TWO COUNTERACTING TOOLS, DOUBLE-WRENCH TECHNIQUE, WHEN DISCONNECTING OR TIGHTENING TERMINALS ON THE BATTERY OR THE AC MOTOR. FAILURE TO COMPLY COULD CAUSE CRACKING OF THE TERMINAL OR BATTERY POST WELDS.

NOTICE Follow the maintenance instructions applicable to the type of repair, maintenance, or service.

NOTICE Before maintenance operations, inspect safety decals and labels. Replace if any damage is found and part of the text can't be read.

4.1.1 LIFTING POINTS

Please refer to the serial data plate (see Figure 19), positioned on the left side of the console, to determine the total weight of the vehicle. It is important to note that the weight may differ based on the vehicle's specific configuration, accessories, and battery capacity.

When utilizing a lifting device, ensure that it can support the precise weight of the vehicle. The suggested lifting points are highlighted below (Figure 20) as a guide for safe and efficient lifting operations.

WARNING

BEFORE LIFTING, ALWAYS VALIDATE THAT THE LIFTING DEVICE CAN SUPPORT THE TOTAL WEIGHT OF THE VEHICLE, AS INDICATED ON THE VEHICLE'S SERIAL DATA PLATE. FAILURE TO COMPLY CAN LEAD TO SERIOUS INJURIES OR DEATH.

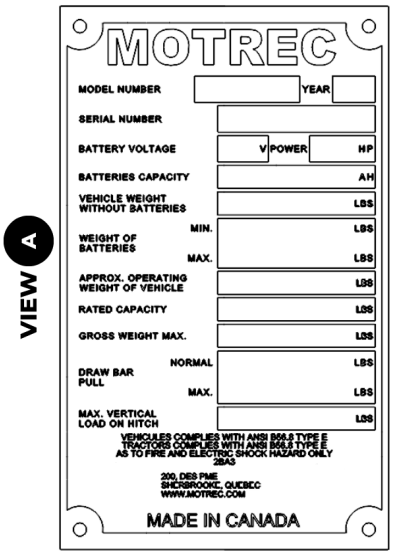


Figure 19. Serial Data Plate.

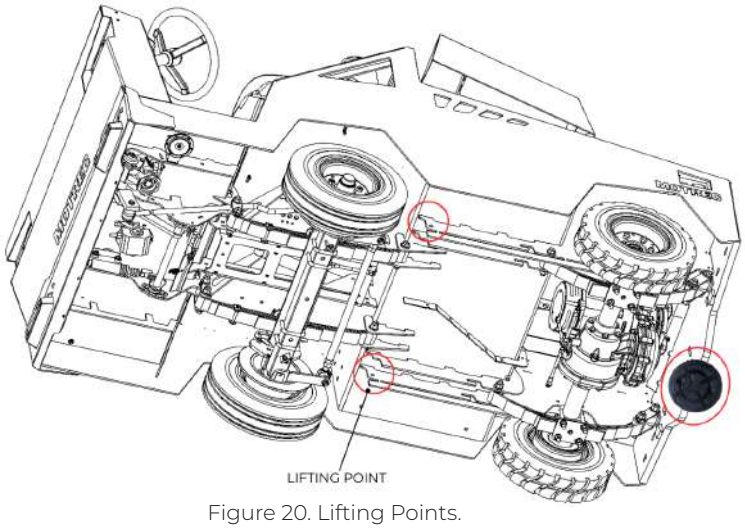


Figure 20. Lifting Points.

NOTE : To elevate the vehicle, a rubber jack positioned at the rear center is used.

Figure 21. Jack Rubbers Used For Lifting

WARNING

ENSURE THAT YOU USE A JACK WITH SUFFICIENT LIFTING CAPACITY TO ELEVATE THE VEHICLE. A REGULAR WORKSHOP JACK IS NOT SUITABLE AND MAY FAIL TO SUPPORT THE VEHICLE'S WEIGHT.

WARNING

AFTER LIFTING, CAREFULLY CHECK THE VEHICLE'S STABILITY BEFORE BEGINNING ANY WORK UNDERNEATH.

4.1.2 ELECTRICALLY ISOLATING THE VEHICLE

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

This procedure must be followed to isolate the vehicle from any electrical charge:

1. Remove the key.
2. Turn off all switches.

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS DISCONNECT THE CHARGER AND USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

3. Lift the battery cover to reach the batteries.
4. Disconnect the battery pack by unplugging the SB-350 connector (See figure 5 page 11).
5. Discharge the capacitor in the AC motor controller (1) by connecting a 10 ohms / 25 W resistor (2) for a few seconds across the AC motor controller's (1) **B+** and **B-** terminals. Do not leave the resistor (2) on the terminals once discharged.
6. Using a multimeter, validate the absence of voltage between the AC motor controller's (1) **B+** and **B-** terminals.
7. To reconnect the electrical circuit, perform this procedure in reverse.
   - **NOTE :** No resistor needed for reconnection.

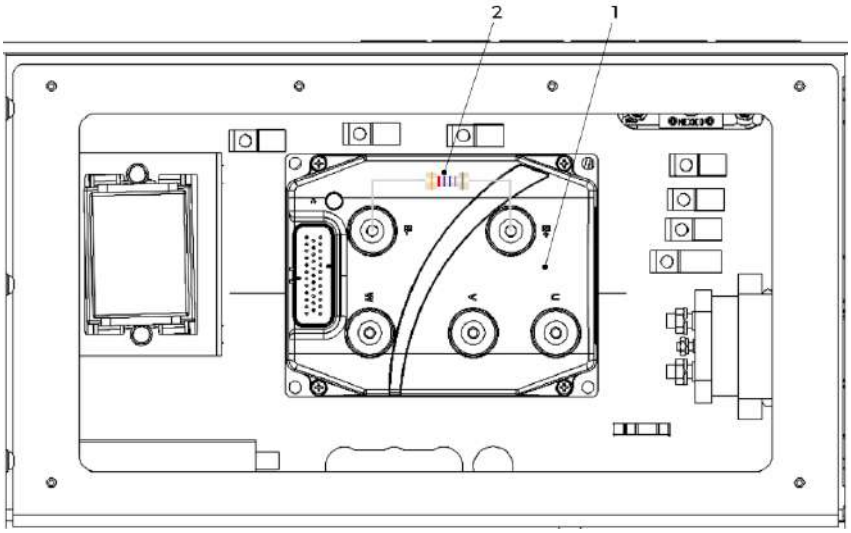


Figure 22. AC Motor Controller Terminals.

4.2 PREVENTIVE MAINTENANCE

WARNING

FOLLOW THE MAINTENANCE SCHEDULE PROVIDED IN THIS MANUAL. FAILURE TO COMPLY CAN LEAD TO INJURIES OR DAMAGE TO THE VEHICLE.

NOTICE

The preventive maintenance schedule specifies the minimum maintenance requirements based on standard use of the vehicle. An early preventive maintenance could be required if the vehicle is operated under severe conditions.

Preventive maintenance is essential for ensuring the durability of the product and the safety of the operator. Maintenance should be conducted at specific intervals (daily, weekly, 250 hours, 500 hours, 1000 hours, or 2000 hours), depending on the vehicle's runtime or the time elapsed, whichever occurs first. This proactive approach helps identify and address any potential issues before they escalate, contributing to the overall longevity and optimal performance of the product.

NOTE : The vehicle runtime is counted while the vehicle is in operation, and won't be affected while the key is in the ON position and the vehicle is idle. The vehicle runtime can be found on bottom left of the display screen when starting the vehicle.

Maintenance Timer Reset

When the vehicle reaches its predefined vehicle runtime limit, the vehicle speed will be reduced and the fault code 54 will appear on the dashboard to inform the operator that maintenance is due. It does not indicate a defect of any sort.

Once the preventive maintenance is completed, the timer must be reset, and the fault code erased. The timer can be reset as follows:

1. Put the ignition key ON.
2. Hold the **Enter** button for 5 seconds.
3. Select **Operation Menu**.
4. Select **Reset Maintenance Monitor**.
5. Select **Reset** and exit.

4.2.1 DAILY MAINTENANCE

Special Tools	Consumables
▸ N/A	▸ N/A

NOTICE Replace any defective component found during the inspection listed below.

Maintenance Procedures

Visible Damage Inspection

Inspect for excessive visible damage on the exterior of the vehicle or to components under the vehicle.

Fluid Leaks Inspection

A leak could come from the differential or the brake system. The vehicle may be lifted for further inspection of this symptom as required.

Proceed as follows to inspect:

1. Inspect the master cylinder (1).

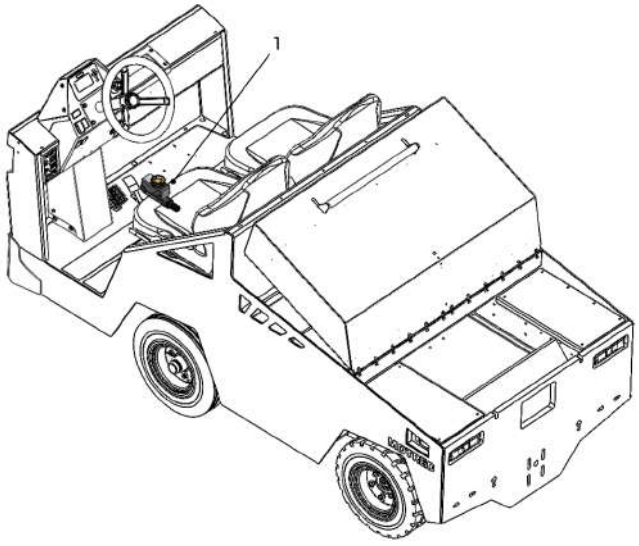


Figure 23. Front Fluid Leaks.

2. Remove the motor cover (2).

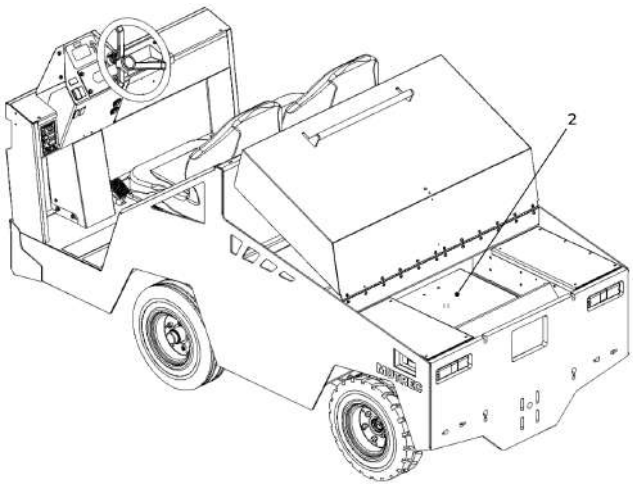


Figure 24. Deck Removal.

3. Inspect the drive assembly (3) for signs of leaks at following locations:
   - Axle ends.
   - Right and left casings mating surfaces.
   - Drain/fill plugs.

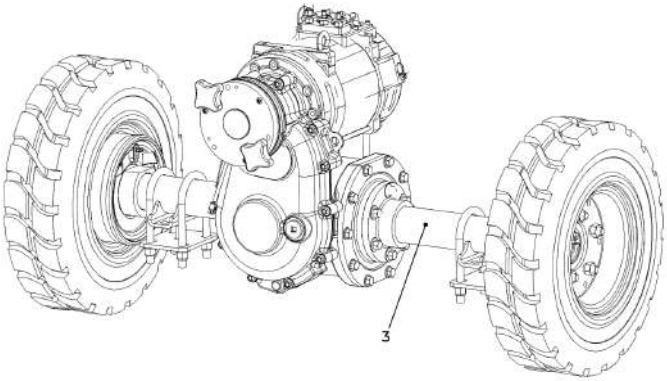


Figure 25. Drive Assembly Fluid Leaks.

4. Reinstall the motor cover (2).

Static Strap Inspection

Check the static strap (1) (if applicable) for signs of excessive wear and ensure it has an adequate length. When the vehicle is on its wheels and stationary, the strap should have a minimum of two inches in contact with the ground.

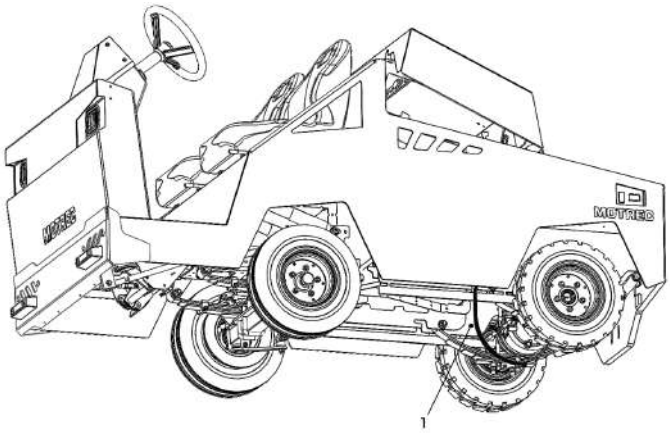


Figure 26. Static Strap.

Steering Inspection

Rock the steering wheel and Inspect the steering system for hard steering, excessive play, leaks or unusual sounds when turning.

Horn and Lights Inspection

Inspect the correct operation of all lights, strobe, horn, and reverse alarm.

Seat Switch Inspection

1. Check that the seat switch is operational by sitting on the driver's seat and validating that no fault is generated on the display while sitting.
2. Validate that the vehicle stops when removing all weight from driver's seat.

⚠ WARNING

DO NOT EXCEED SPEED OF 1 MPH (2 KM/H) WHEN TESTING THE SEAT SWITCH. THE DEACTIVATION OF THE SEAT SWITCH WILL STOP THE VEHICLE SUDDENLY. FAILURE TO COMPLY CAN CAUSE INJURY.

Accelerator Pedal Inspection

1. Inspect the accelerator pedal for free movement and proper return spring tension.
2. Test the accelerator pedal's sensitivity and response. It should provide a smooth and predictable increase in motor as the pedal is pressed. Any delays or irregularities in the response may indicate a problem.

Brake Pedal Inspection

1. Test the pedal's ability to engage and disengage the braking system smoothly. Any inconsistencies or difficulty in brake pedal operation could indicate problems with the mechanical components or linkage.
2. Inspect the pedal for free movement and firm pedal.

Emergency Button Inspection

1. Visually inspect the button for any visible damage or irregularities.
2. Test the emergency button to verify that it activates as intended. Ensure it depresses and releases smoothly without any sticking.

4.2.2 WEEKLY MAINTENANCE

Special Tools	Consumables
▸ N/A	1. Distilled water

NOTICE Replace any defective component found during the inspection listed in this procedure.

Maintenance Procedures

Tire Pressure Inspection

Check that each tire maintains a pressure rating of approximately 60 psi (only if the tires are pneumatic). Additionally, thoroughly inspect the tires for any signs of of punctures, damage or excessive wear.

Battery Electrolyte Inspection and Top-Up

1. Fully charge the batteries.

NOTE : When the batteries are charged, the fluid expands and can seep out if overfilled. Refill each cell after full charge when the fluid has expanded to its maximum level.

2. Lift the battery cover using the handle, to access the batteries.
3. For each battery in the batteries compartment, inspect and refill as necessary with distilled water to the recommended manufacturer level.
4. Lower the battery cover to conceal the batteries.

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

WARNING

DO NOT OPEN THE BATTERY COMPARTMENT BEFORE DISCONNECTING THE CHARGER. BATTERIES EMIT HIGHLY EXPLOSIVE GASES WHICH GREATLY INCREASE WHEN CHARGING. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

4.2.3 EVERY 250 HOURS OR 3 MONTHS MAINTENANCE

Special Tools	Consumables
▸ Resistor: 10 ohms, 25 W ▸ Lifting device	▸ Lubricant spray ▸ Multi-purpose Grease

NOTICE Replace any defective component found during the inspection listed in this procedure.

NOTICE When required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.

Maintenance Preparation Steps

Before conducting any maintenance tasks, it is essential to follow the subsequent steps to ensure safety during maintenance and enable easy access to components.

1. Lift the battery cover (1).

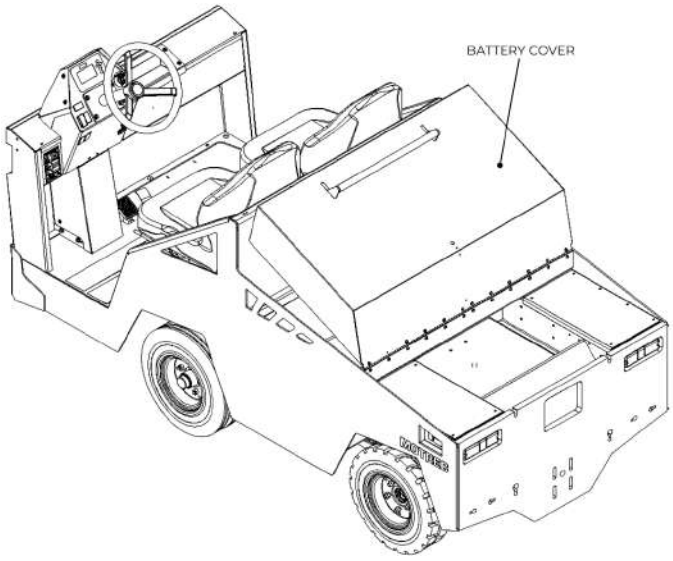


Figure 27. Battery Cover Lifting.

2. Remove the kick panel (2).
3. Remove the dashboard cover (3).

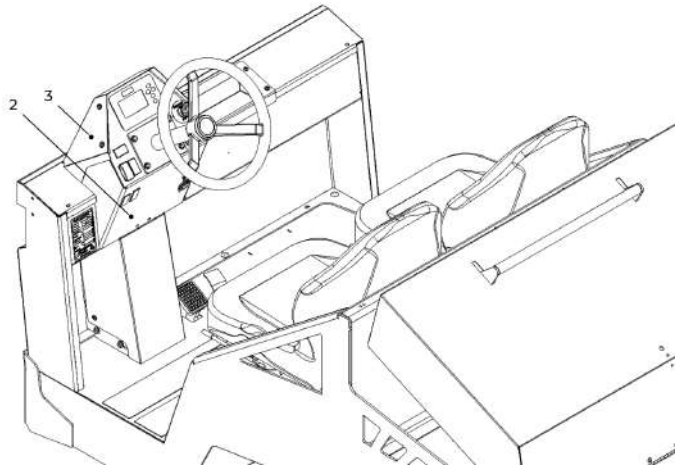


Figure 28. Kick Panel and Dashboard Cover.

⚠ WARNING

DO NOT WORK ON ANY COMPONENTS OF THE ELECTRICAL SYSTEM UNTIL THE VEHICLE IS ELECTRICALLY ISOLATED. VOLTAGES OF UP TO 50 V AND HIGHER CAN BE PRESENT. FAILURE TO COMPLY CAN CAUSE INJURIES.

4. Take the necessary steps to remove electrical hazards in accordance with **Section 4.1.2** page 27, which provides guidelines for electrically isolating the vehicle.

Maintenance Procedures

Suspension Inspection

1. Inspect the following equipment for damage and corrosion:
   - Rear leaf springs (1) and their fixtures.
   - Front leaf springs (2) and their fixtures.
   - Front shock absorbers (2).
2. Inspect all suspension frame bearings for play.

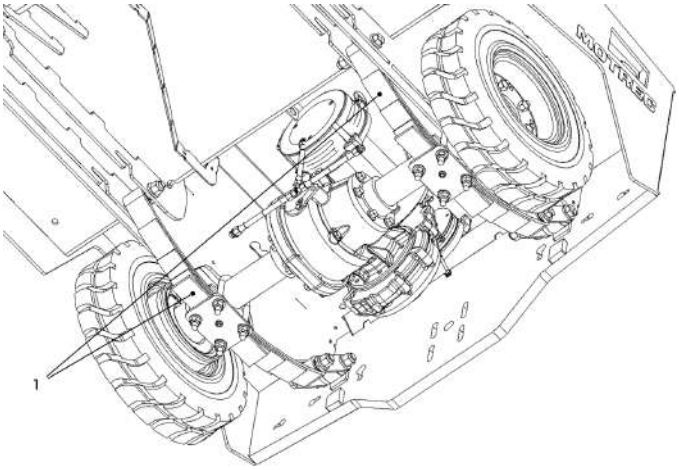


Figure 29. Rear Suspension Inspection.

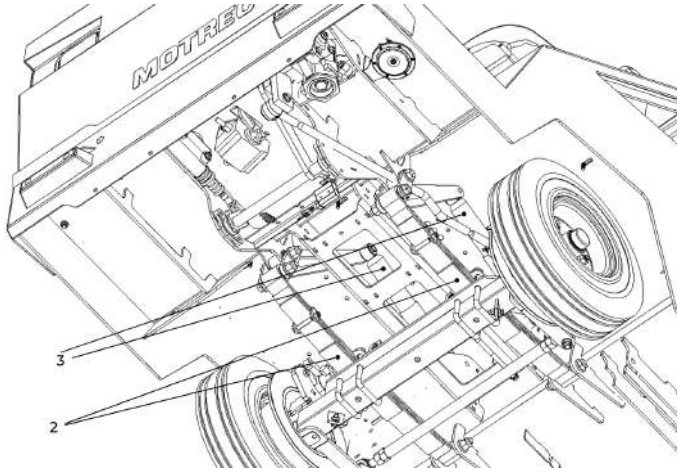


Figure 30. Front Suspension and Shock Absorbers Inspection.

Rubber Bumper Inspection

Inspect rubber bumper installed on the vehicle components for signs of damage, cracks or dryness.

Figure 31. Rubber Bumper Inspection.

Steering Inspection

1. Inspect the two universal joints (1) and the four tie rods ends (2) for:
   - Play.
   - Damage.
   - Binding.
   - Corrosion.

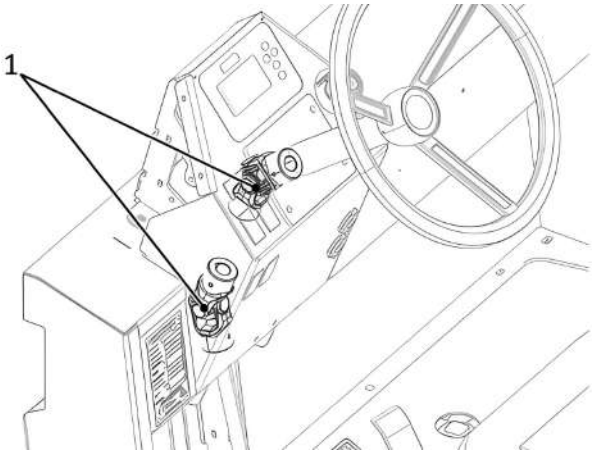


Figure 31. Universal Joints Inspection.

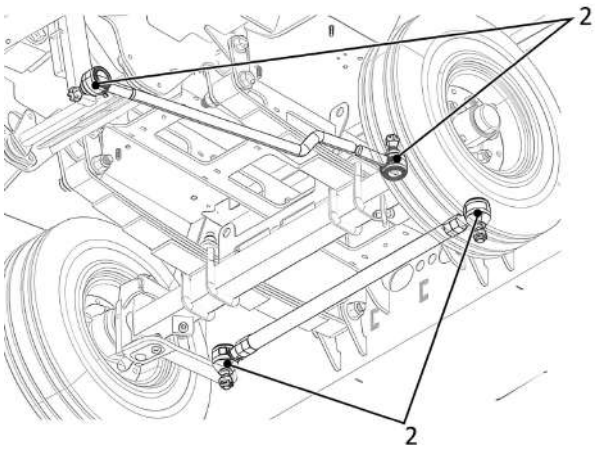


Figure 32. Tie Rods Ends Inspection.

2. Inspect the following elements for damage or corrosion:

   - Steering shafts (3).
   - Coupler (4).
   - Steering gearbox (5).
   - Pitman arm (6).
   - Axle beam (7).
   - Right and left spindles (8).

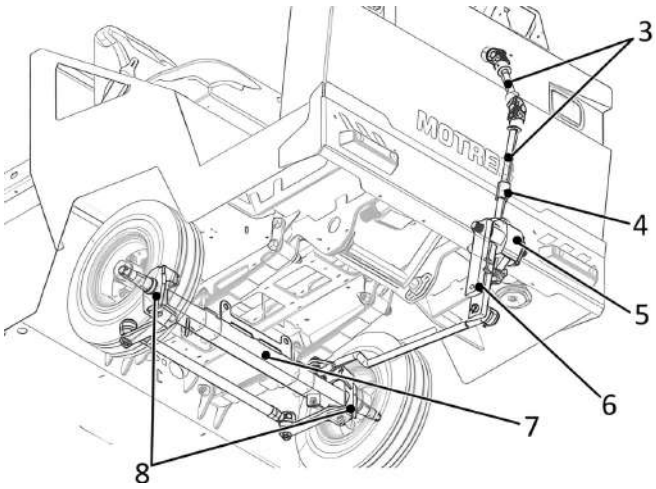


Figure 33. General Steering Inspection.

Grease Fittings Lubrication

Lubricate the grease fittings of the following components (See Figure 31 and Figure 32) :

- The two universal joints (1).
- The four tie rods ends (2).

Lubrication

Lubricate the following components using lubricant spray:

- Brake pedal assembly and flange bearings (see Figure 11 page 17).
- Master Cylinder Push Rod (see Figure 11 page 17).

Electromagnetic Brake Inspection

1. Chock the vehicle's wheels.
2. Remove the electromagnetic brake's rubber shield (1).
3. Insert the service knobs (2) to free the electromagnetic brake's rotor.
4. Clean the gap (3) created with compressed air.
5. Remove the service knobs (2) from the electromagnetic brake.

Figure 34. EMB Inspection.

6. Using a feeler gauge, measure the air gap (3) between pressure plate (4) and the electromagnet (5).
   - → If the air gap is **0.030" or less**, skip to next step.
   - → If the air gap is **greater than 0.030**", check the tag on the electromagnetic brake:
   - – Replace the EMB's rotor if a CNX brake is installed.
   - – Replace the EMB assembly if a Warner brake is installed.
7. Reinstall the rubber shield (1). Replace rubber shield (1) if the rubber shows any sign of dryness or damages.

AC Motor Dusting

If the vehicle is equipped with the fan cooled AC motor, clean the motor's air vents (1) with compressed air.

NOTE : Clean any dust accumulation on other components if necessary.

In the case of a Sealed motor, it provides inherent protection against dust and debris. Therefore, no additional dusting or cleaning is necessary for the motor.

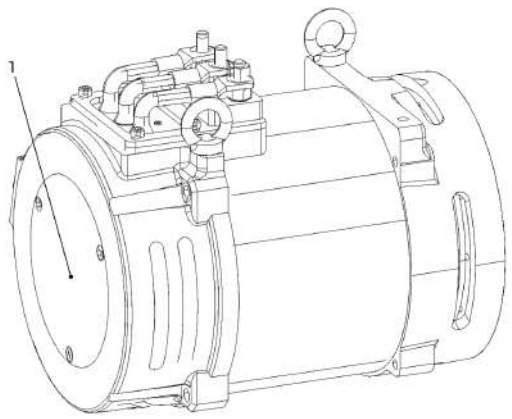


Figure 35. AC Motor.

Power Circuit Inspection

1. Inspect the power cables for visible damage.
2. Inspect the electrical connections for:
   - – Corrosion.
   - – Loose connections.

Battery Inspection

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFURIC ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

1. Inspect the batteries for the following elements:
   - – Loose connections.
   - – Damaged cables.
   - – Acid spill.
   - – Loose terminal posts.
   - – Corrosion.
   - – Swelled casing.
2. If corrosion is present on battery posts:
   a. Remove the cable connectors.
   b. Use a wire brush to remove any particles.
   c. Clean the terminals with a suitable product.
   d. Reinstall the removed cables.

CAUTION

AFTER CLEANING, DO NOT REAPPLY POWER UNTIL TERMINAL AREAS ARE THOROUGHLY DRY. FAILURE TO COMPLY CAN DAMAGE THE VEHICLE.

Test Drive

After the maintenance is finished, it is necessary to reinstall any disassembled parts and conduct a thorough test on the vehicle to ensure that all systems are functioning correctly.

1. Reconnect the electrical circuit:
    i. Reconnect the SB-350.
    ii. Insert the key.
    iii. Turn on all switches and test lights.
2. Test drive the vehicle:
    i. Turn the steering wheel and feel for excessive play.
    ii. Switch the drive mode from Turtle to Rabbit and test the speed.
    iii. Depress and release the accelerator to test the electromagnetic brake.
    iv. Listen for abnormal noise.
3. Lower the battery cover.
4. Reinstall the control panel.
5. Reinstall the dashboard cover.

4.2.4 EVERY 500 HOURS OR 6 MONTHS MAINTENANCE

Special Tools	Consumables
▸ Resistor: 10 ohms, 25 W	▸ DOT-3 fluid brake

NOTICE Replace any defective component found during the inspection listed in this procedure.

NOTICE When required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.

NOTICE The 250 hours or 3 months preventive maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy.

Maintenance Preparation Steps

Before conducting any maintenance tasks, it is essential to follow the subsequent steps to ensure safety during maintenance and enable easy access to components.

4. Take the necessary steps to remove electrical hazards in accordance with **Section 4.1.2** page 27, which provides guidelines for electrically isolating the vehicle.

⚠ WARNING

DO NOT WORK ON ANY COMPONENTS OF THE ELECTRICAL SYSTEM UNTIL THE VEHICLE IS ELECTRICALLY ISOLATED. VOLTAGES OF UP TO 90 V AND HIGHER CAN BE PRESENT. FAILURE TO COMPLY CAN CAUSE INJURIES.

Maintenance Procedures

Decals and Labels Inspection

Inspect decals and safety labels for damage. Replace them if any part of the text is illegible.

Frame Inspection

1. Inspect the vehicle's frame for Cracks, damage or Corrosion.
2. The following frame locations should be inspected with care:
   - Side panels corners (1) (both sides). There is a possibility of cracks occurring in these corners as they undergo significant stress (see Figure 36).
   - Front suspension mounting tabs (2) (see Figure 37).
   - Rear suspension mounting tabs (3) (see Figure 38).
   - Weld zones (4) (see Figure 39, not all welds are shown).

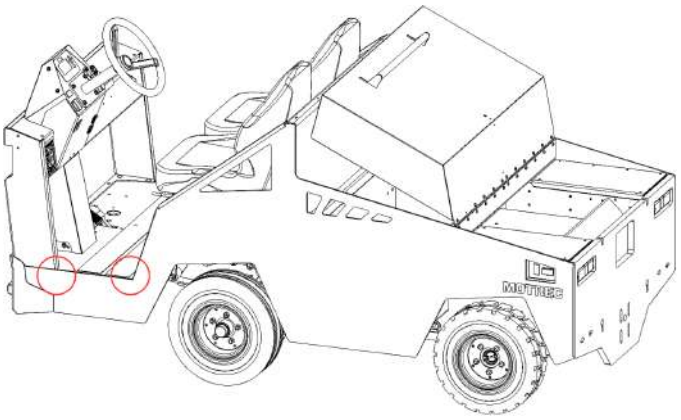


Figure 36. Side Panels.

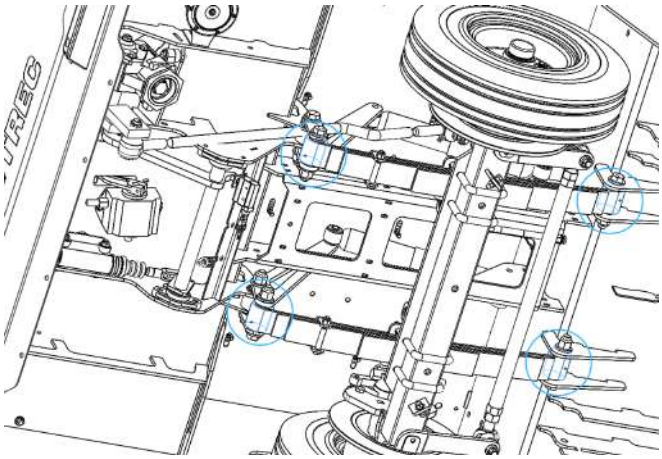


Figure 37. Front Suspension Mounting Tabs.

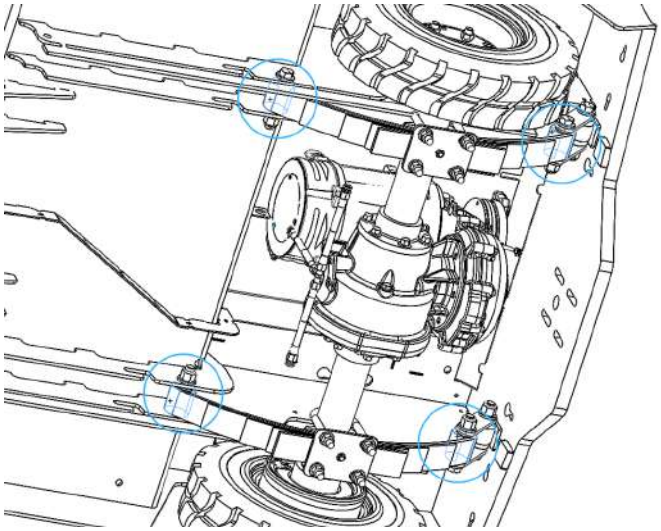


Figure 38. Rear Suspension Mounting Tabs.

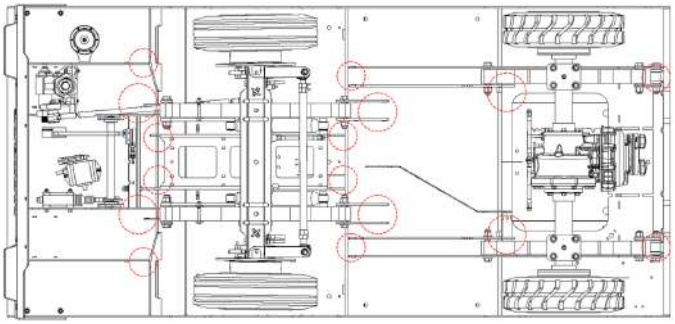


Figure 39. Weld Zones.

Brake System Inspection

1. Inspect the brake system components (1) for signs of corrosion, damage or leaks.
2. Inspect the brake fluid level in the master cylinder (2) placed underneath the master pedal mat. Refill with DOT-3 fluid brake if required.

   NOTE : A low level of brake fluid indicate either brake wear or fluid leaks.
3. Check brake mechanical linkages for wear and play.
4. Check brake linings for wear (1/16" (1 mm) minimum lining thickness).

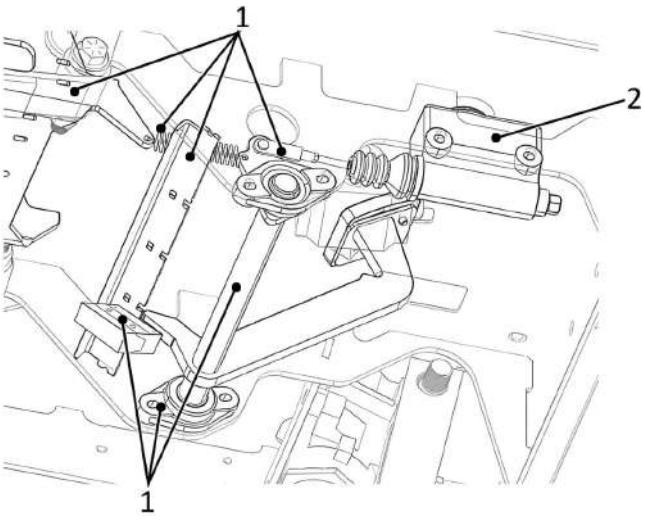


Figure 40. Brake System Inspection.

Front Disc Brake Inspection

proceed as follows for each of the vehicle's disc brake inspection:

1. Remove all wheel nuts (1) to remove the wheel (2).

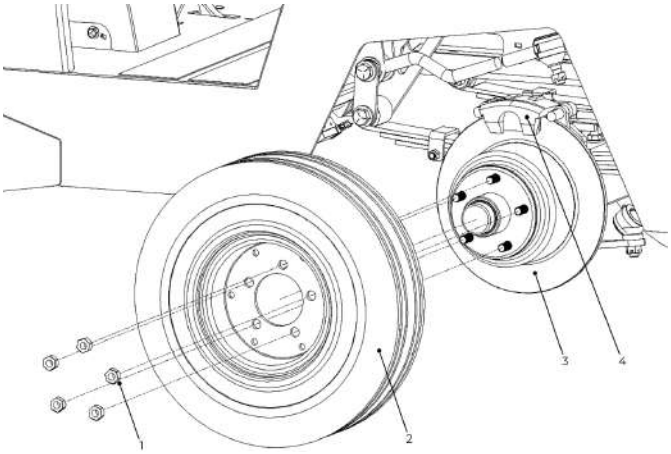


Figure 41. Wheel Removal.

2. Remove the slide pins (5) to release the caliper (4) from the disc (3).
3. Clean both caliper (4) and slide pins (5) from any dust or debris.
4. On the disc (3), clean the seating surface of the caliper (4) from any debris.

Figure 42. Slide Pins and Caliper Removal.

5. Inspect the brake pads (6). Replace them if the lining thickness is 1/16 in (2 mm) or less.
6. Clean the following elements to remove any dust or debris:
   - Shims (7).
   - Shims holders (8).
   - Gap in the brake pad (9).

Figure 43. Brake Pads and Shims Inspection.

7. Reassemble all components in the reverse sequence and don't forget to grease the slide pins (5) before returning them to their place.

   NOTE : Regarding the wheel nuts (1), tighten them to the specified standard torque value of 80 ft lbs.

Front Wheels Bearings Inspection

Inspect all wheel bearings for:

- Play.
- Stiffness.
- Abnormal noise.

NOTE : Please refer to page 44, specifically the "Front Wheel Bearings Maintenance" section, for instructions on replacing the bearing.

Kingpins Inspection

1. Inspect the kingpins (1) assembly of the two front wheels for the following:

   - Play.

   - Damage.

   - Corrosion.

2. Inspect the condition of the castle nut (2) and the cotter pin (3).

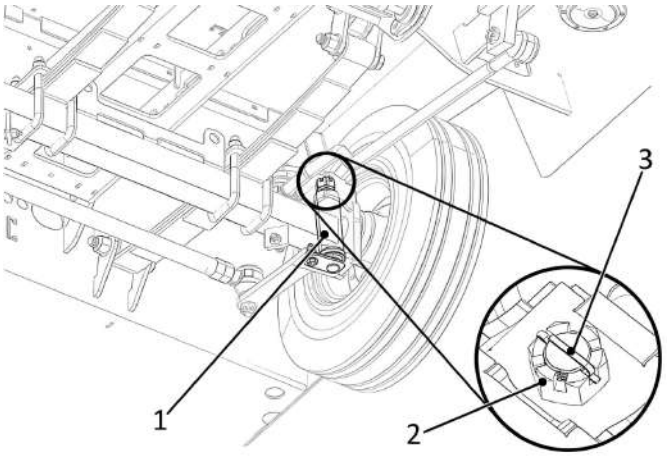


Figure 44. Kingpins Inspection.

Rear Drum Brakes Inspection (MT-440 Only)

proceed as follows for each of the vehicle's rear drum brakes:

1. Remove the wheel nuts (1) and wheel (2)
2. Remove the brake drum (3).
3. Clean brake dust with water.
4. Inspect the drum brake (3) for excessive wear or scoring.
5. Inspect the drum shoes. Replace the shoes and springs if the lining thickness is 1/16 in (2 mm) or less.

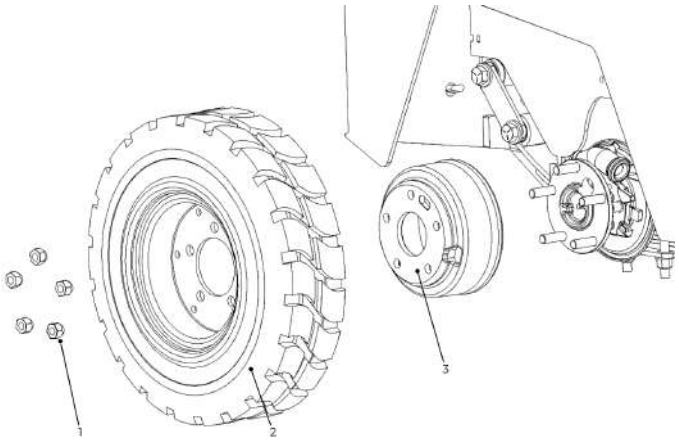


Figure 45. Drum Brakes Inspection.

6. Reinstall the brake drum (3)
7. Reinstall the wheel (2) and the wheel nuts (1). Torque the wheel nuts (1) to standard values. The appropriate torque value is 80 ft lbs.

Rear Drum Brakes Inspection (MT-440 N Only)

1. Examine the thickness of the shoe brake (2) by passing a flashlight through the hole (1). Confirm that the thickness is a minimum of 1mm.

Figure 46. Rear Drum Brake Inspection.

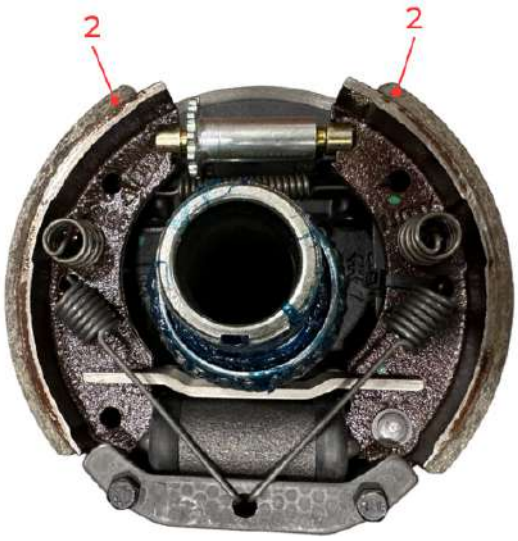


Figure 47. Shoe Brake Thickness Inspection.

Benevelli Differential maintenance (MT-440 N Only)

After 500 hours of use, it is essential to perform an oil check and top-up through the upper oil plug (1) as required for continued optimal performance.

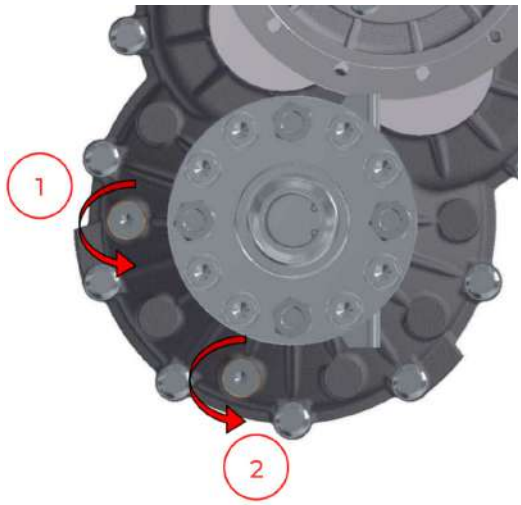


Figure 48. Checking and Topping Up Oil.

4.2.5 EVERY 1000 HOURS OR 12 MONTHS MAINTENANCE

Special Tools	Consumables
▸ Resistor: 10 ohms, 25 W ▸ Lifting device ▸ Slings ▸ Oil recipient	▸ Differential oil: SAE 80W90 GL5 ▸ Molybdenum disulfide grease (6g) ▸ Permatex RTV gasket maker (P/N 81182) ▸ Lubricant spray ▸ Bearing grease ▸ Hub Seal ▸ Cotter pin (Size : 1/8x2)

NOTICE When required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.

NOTICE The 500 hours or 6 months preventive maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy.

Maintenance Preparation Steps

Before conducting any maintenance tasks, it is essential to follow the subsequent steps to ensure safety during maintenance and enable easy access to components.

4. Take the necessary steps to remove electrical hazards in accordance with **Section 4.1.2** page 27, which provides guidelines for electrically isolating the vehicle.

⚠ WARNING

DO NOT WORK ON ANY COMPONENTS OF THE ELECTRICAL SYSTEM UNTIL THE VEHICLE IS ELECTRICALLY ISOLATED. VOLTAGES OF UP TO 90 V AND HIGHER CAN BE PRESENT. FAILURE TO COMPLY CAN CAUSE INJURIES.

Maintenance Procedures

Drive Splines Maintenance

1. Disconnect all electrical cables from the AC motor (1).
2. Place the slings around the motor.
3. Support the AC motor (1) with the appropriate lifting device so that the motor can be slightly moved horizontally.

! CAUTION

DO NOT REMOVE THE AC MOTOR FROM THE DIFFERENTIAL UNTIL IT IS CORRECTLY SUPPORTED. THE MOTOR WEIGHS ABOUT 40 LB (18 KG). FAILURE TO COMPLY CAN DAMAGE THE EQUIPMENT.

4. Remove the screws (2) joining the AC motor (1) to the differential (3).

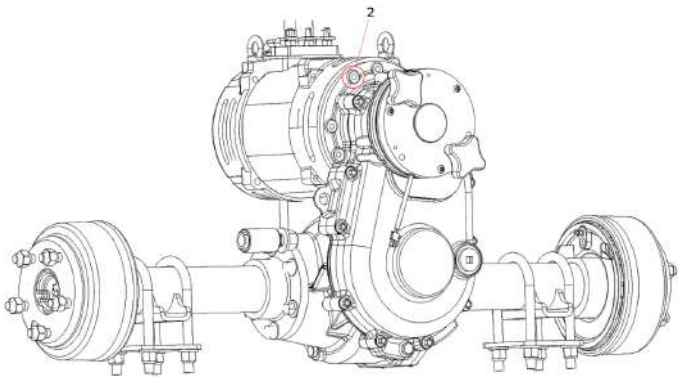


Figure 49. a. Disconnecting AC Motor (For Mt-440).

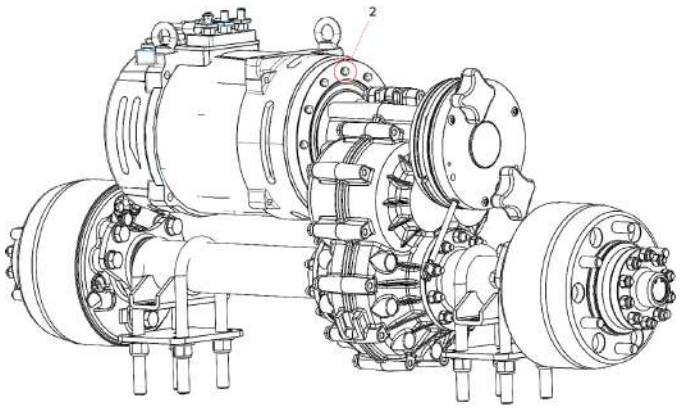


Figure 49. b. Disconnecting AC Motor (For Mt-440N).

5. Remove the AC motor (1) from the differential (3), to access the drive splines (4).

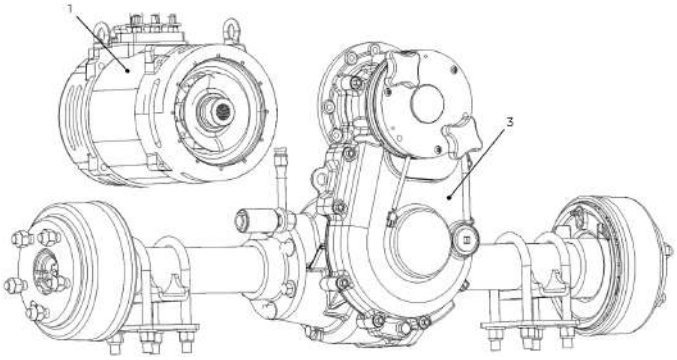


Figure 50. a. Removing AC Motor (MT-440).

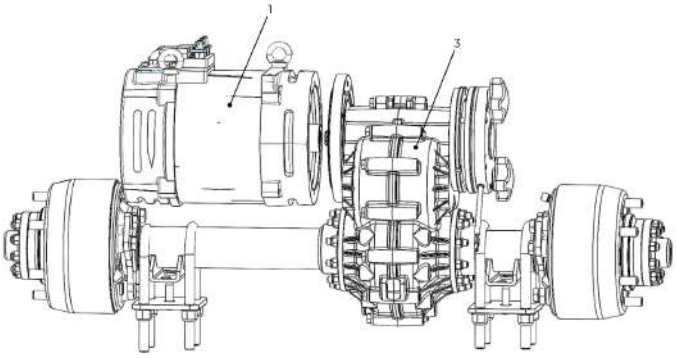


Figure 50. b. Removing AC Motor (MT-440N).

6. Clean the AC motor (1) from dust or debris accumulation (if applicable).
7. Inspect the AC motor and the differential drive splines (4) for corrosion or damage.
8. Lubricate the AC motor and the differential drive splines (4) with molybdenum disulfide grease (2.5 ml is required).

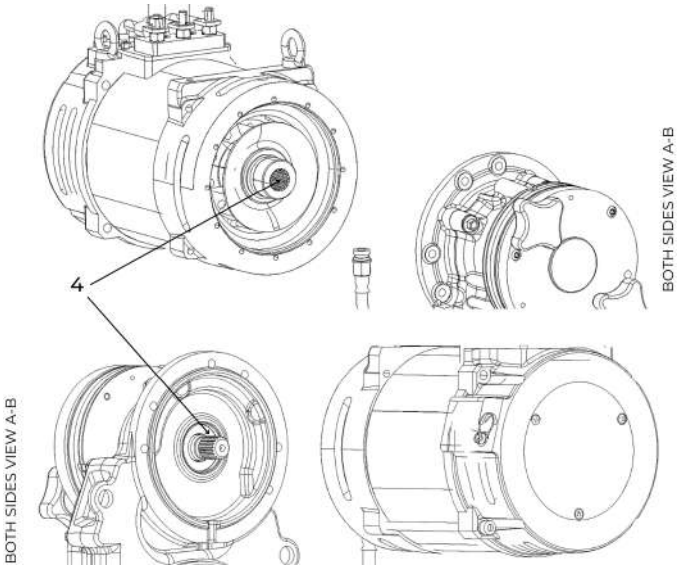


Figure 51. a. Spline Lubrication (MT-440).

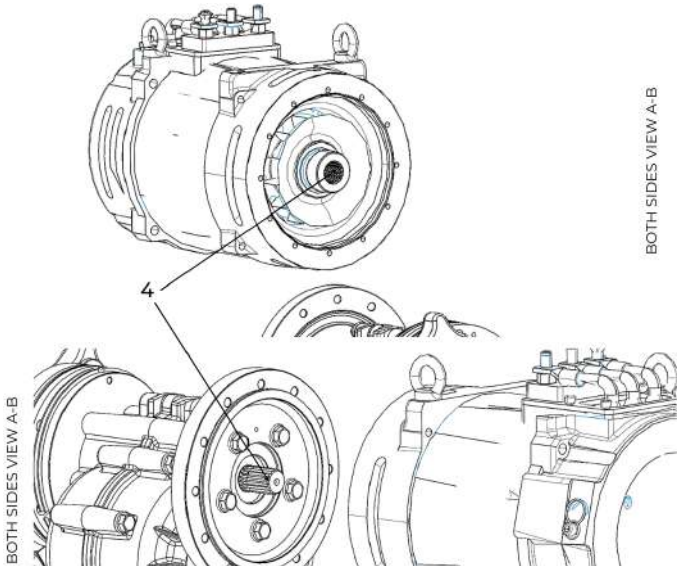


Figure 51. b. Spline Lubrication (MT-440N).

9. Reinstall the AC motor (1) on the differential (3) with the seven screws (2).
10. Torque the screws (2) to standard values. The appropriate torque value is 24 ft lbs.
11. Remove the slings from the AC motor (1).
12. Reconnect the electrical cables to the AC motor (1).

NOTE : Ensure that the connections are properly reestablished, matching the corresponding letters U, V, and W from the controller with the corresponding letters on the motor.

Front Wheels Bearings Maintenance

1. Chock the rear wheels.
2. Remove wheel nuts (1) to remove the wheel (2).

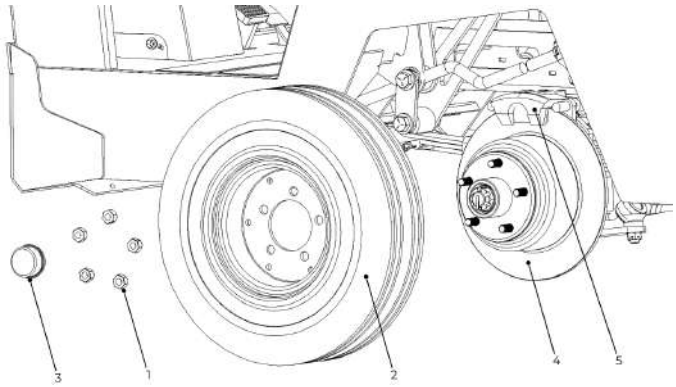


Figure 52. Wheel Removal.

3. Remove the dust cap (3).
4. Remove the slide pins (6) to release the caliper (5) from the disc (4).
5. Remove the disc (4).

Figure 53. Slide Pins and Caliper Removal.

6. Remove the cotter pin (7) and unscrew the castle nut (8).
7. Remove the hub (9) from the spindle (10).

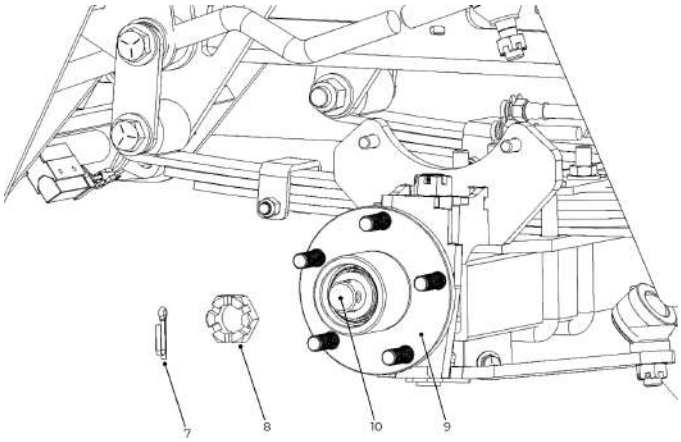


Figure 54. Cotter Pin, Castle Nut and Hub Removal .

8. Inspect the bearings (11) and their races for wear.
9. Inspect the seal (12) for wear.
10. Clean the bearing (11) and if they are still usable, apply the grease.

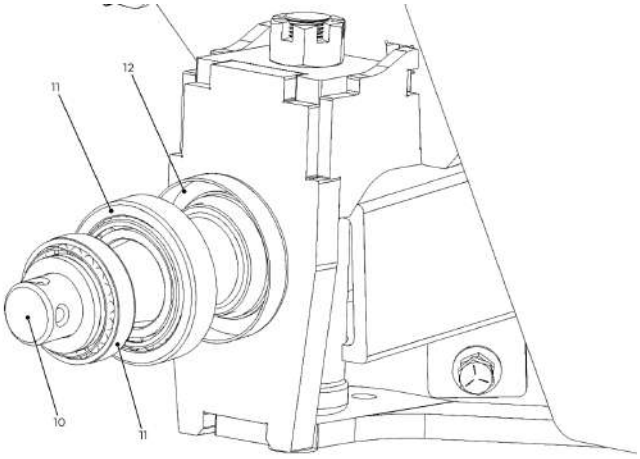


Figure 55. Bearing Inspection.

11. Reassemble all components in the reverse sequence and don't forget to grease the slide pins (6) before returning them to their place.

NOTE : Regarding the wheel nuts (1), tighten them to the specified standard torque value of 80 ft lbs.

Rear Hub Maintenance (MT440-N Only)

1. Chock the front wheels.
2. Remove the wheel nuts (1) and wheel (2).

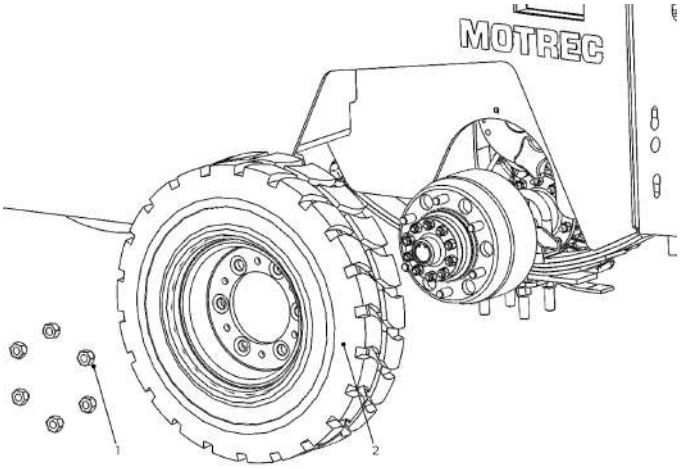


Figure 56. Rear Wheel Removal.

3. Remove the 10 bolts (3).

Figure 57. Bolts Removal.

4. Remove the axle hub cap (4).

Figure 58. Axle Hub Cap Removal.

5. Remove the rear axle shaft (5).
   5. 1. Unfold lock washer tab.

Figure 59. Rear Axle Shaft Removal.

6. Remove the ring nut (6) with a ring nut removal tool (7) (Motrec PN : 5500000133).

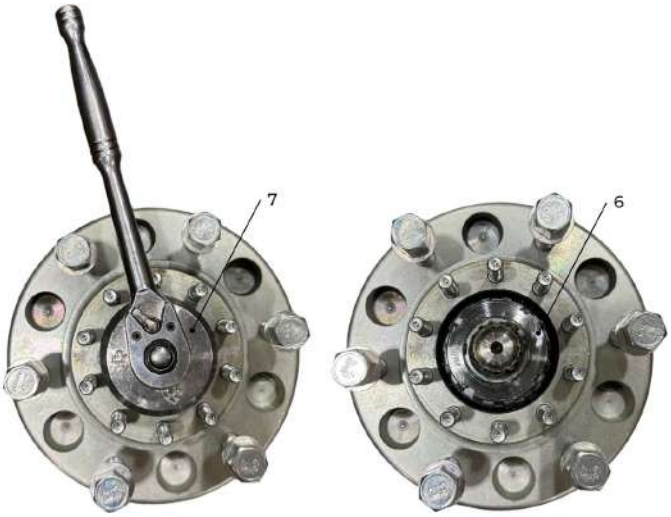


Figure 60. Ring nut Removal.

7. Remove the axle end lock washer (8).

Figure 61. Axle End Lock Removal.

8. Remove the brake drum (9).

Figure 62. Wheel Studs and Brake Drum Removal.

9. Clean brake dust with water and inspect drum brake system (10) for any debris.

Figure 63. Brake System Inspection.

10. Inspect the bearings (11) and their races for wear.

Figure 64. Bearings Inspection.

11. Clean the bearing (11) and if they are still usable, apply the grease.
12. Reassemble all components in the reverse sequence.

NOTE 1 : Tighten the ring nut (6) to 103 ft·lbf to seat the bearings (11), then loosen the ring nut (6) by unscrewing one full turn.

NOTE 2 : Regarding the wheel nuts (1), tighten them to the specified standard torque value of 80 ft lbs.

Schafer Twin-case Differential Maintenance (MT-440 Only)

For vehicles equipped with the Schafer twin-case, proceed as follows :

1. Position a recipient under the differential to collect the drained oil in next steps.
2. For the ALUMINUM CASE :

a. Remove the filler plug (1).

b. Remove the drain plug (2) until the case is completely drained of oil.

c. Reinstall the drain plug (2).

d. Add **625 mL** (stop if the oil reaches the bottom of the filling hole) of SAE 80W90 GL5 differential oil.

e. Reinstall the filler plug (1).

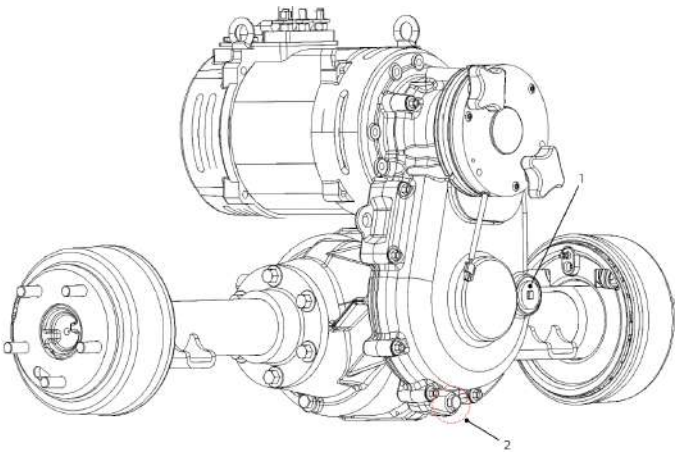


Figure 65. Schafer Aluminum Case.

3. For the CAST-IRON CASE :

a. Remove the filler plug (1).

b. Remove the drain plug (2) until the case is completely drained of oil.

c. Reinstall the drain plug (2).

d. Add **390 mL** (stop if the oil reaches the bottom of the filling hole) of SAE 80W90 GL5 differential oil.

e. Reinstall the filler plug (1).

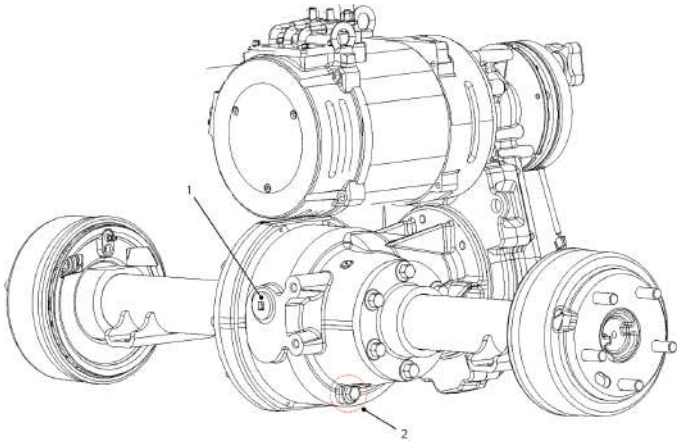


Figure 66. Schafer Cast-Iron Case.

Benevelli Differential Maintenance (MT-440N Only)

The MT-440N vehicle is equipped with a Benevelli differential that requires an oil replacement after 1000 hours (or 12 months) of operation. To perform the oil replacement, proceed as follows :

1. Place the differential on a level surface and remove both the upper oil plug (1) and the lower oil plug (2). Allow the oil to drain into a container.

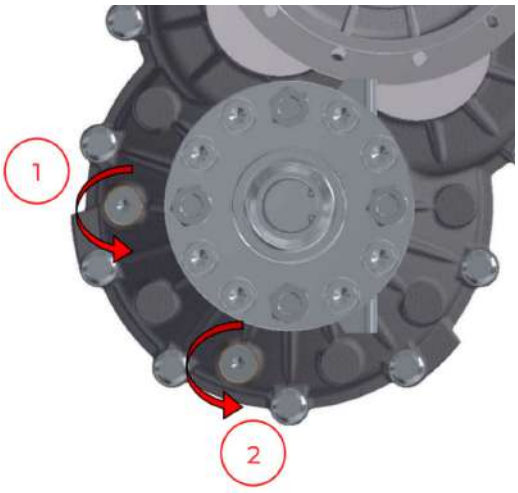


Figure 67. Upper and Lower Oil Plugs Removal.

2. Clean the magnetic oil plug.
3. Tighten the upper oil plug with a torque of 38Nm.

Figure 68. Upper Oil Plug Tightening.

4. Add 0.5 liters of Mobil Mobilube 1 SHC 75W-90 oil.

Figure 69. Adding Oil.

5. Insert a copper washer and securely fasten the lower oil plug, ensuring a tightening torque of 28 ft lbs.

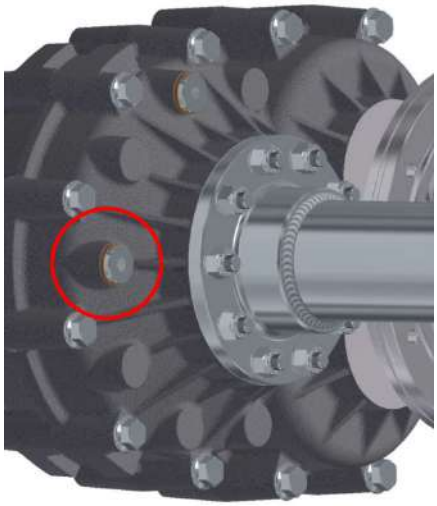


Figure 70. Fastening Oil Plug.

Hardware Maintenance

1. Inspect and tighten all electrical connections. Clean or replace any connection that shows signs of corrosion or damage.
2. Inspect and tighten all mechanical hardware. Replace any connection that shows signs of damage.

Refer to the QUICK REFERENCES at the end of this document for all torque values.

4.2.6 EVERY 2000 HOURS OR 24 MONTHS MAINTENANCE

Special Tools	Consumables
▸ Lifting device	▸ DOT-3 brake fluid

NOTICE The 1000 hours or 12 months preventive maintenance should be carried out concurrently with this maintenance. Certain steps may not be necessary due to redundancy.

Maintenance Procedures

Hydraulic Brake System Fluid Maintenance

NOTE : The most recommended approach for brake fluid replacement is utilizing a bleeder ball tank or a comparable automatic bleeding device. Alternatively, repetitive manual bleeding is also acceptable.

1. If required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.
2. Remove the master cylinder's (1) cap.
3. Bleed rear wheel brakes one at a time :
   i. Fill the master cylinder (1) with DOT-3 brake fluid, then reinstall the master cylinder's (1) cap.
   ii. Bleed the rear wheel cylinders one at a time by having someone apply steady pressure on the brake pedal (2), open the bleeder valve (3) and fully depress the pedal by maintaining the pedal all the way down, and then close the bleeder valve (3) before allowing the brake pedal (2) to return to the up position.

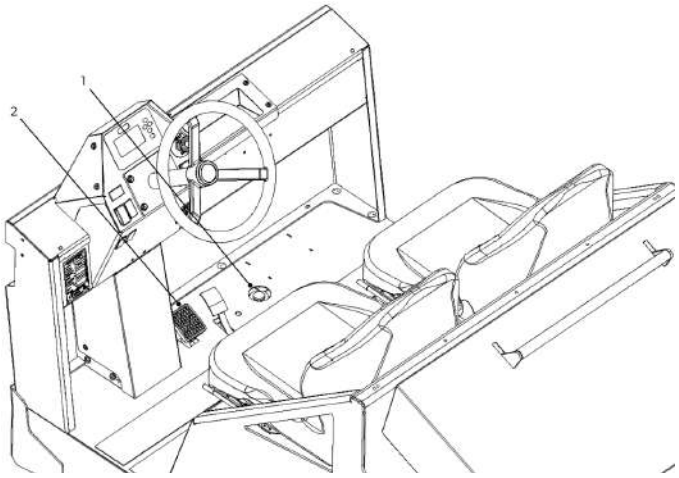


Figure 71. Brake System Bleeding.

4. Once bleeding is completed, top-up the master cylinder (1) with DOT-3 brake fluid.
5. Reinstall the master cylinder's (1) cap.
6. Clean every fitting and line and remove traces of oil.

   NOTE : Exercise with caution as oil fluid can potentially damage the paint.
7. Apply continuous pressure on the brake pedal for about ten seconds. Note any loss of pressure.
8. Inspect the brake lines and fittings for leaks.

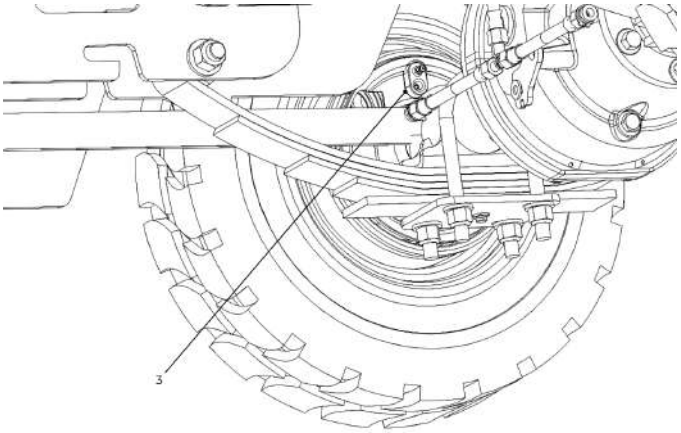


Figure 72. a. Drum Brake Bleeding (MT-440).

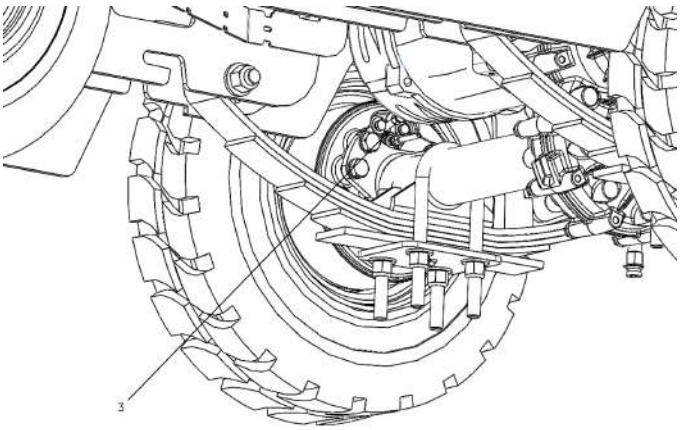


Figure 72. b. Drum Brake Bleeding (MT-440N).

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4.3 CORRECTIVE MAINTENANCE

4.3.1 ACCELERATOR

The accelerator cannot be repaired or serviced. Its maintenance only allows for inspection to verify the correct electrical values. The items that require checking are as follows :

-1/8" (3 mm) travel to activate micro-switch.

-0 to 50 ohms when micro-switch activated.

-4500 to 5500 ohms with pedal down.

4.3.2 HYDRAULIC BRAKES

Brake Pedal Bleeding

NOTE : The most recommended approach for brake fluid replacement is utilizing a bleeder ball tank or a comparable automatic bleeding device. Alternatively, repetitive manual bleeding is also acceptable.

1. If required, lift the vehicle using a lifting device as per section 4.1.1 LIFTING POINTS.
2. Remove the master cylinder's (1) cap.
3. Bleed rear wheel brakes one at a time :
   i. Fill the master cylinder (1) with DOT-3 brake fluid, then reinstall the master cylinder's (1) cap.
   ii. Bleed the rear wheel cylinders one at a time by having someone apply steady pressure on the brake pedal (2), open the bleeder valve (3) and fully depress the pedal by maintaining the pedal all the way down, and then close the bleeder valve (3) before allowing the brake pedal (2) to return to the up position.

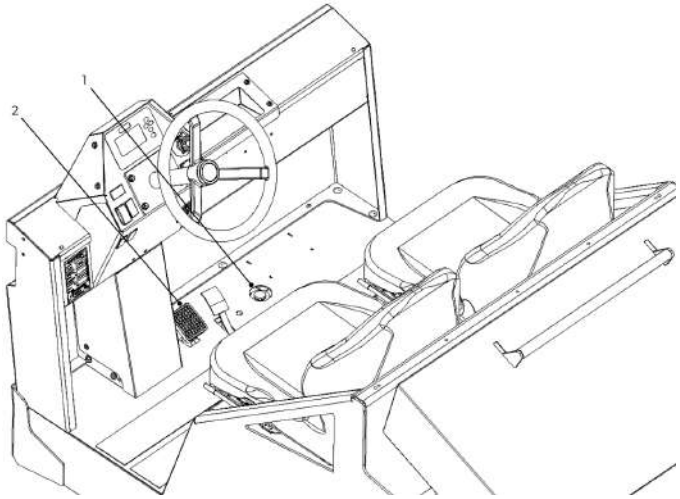


Figure 73. Brake System Bleeding.

4. Once bleeding is completed, top-up the master cylinder (1) with DOT-3 brake fluid.
5. Reinstall the master cylinder's (1) cap.
6. Clean every fitting and line and remove traces of oil.

   NOTE : Exercise with caution as oil fluid can potentially damage the paint.
7. Apply continuous pressure on the brake pedal for about ten seconds. Note any loss of pressure.
8. Inspect the brake lines and fittings for leaks.

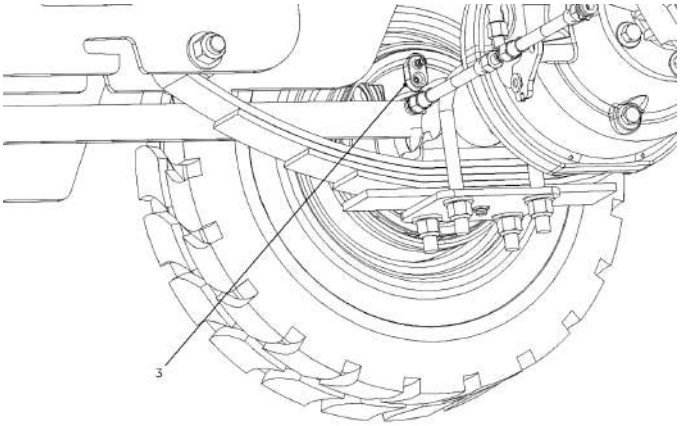


Figure 74. a. Drum Brake Bleeding (MT-440).

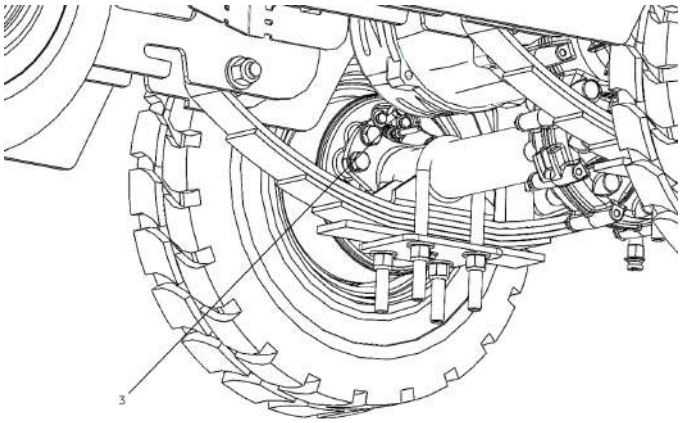


Figure 74. b. Drum Brake Bleeding (MT-440N).

4.3.3 DRUM BRAKES

Drum Brakes Replacement (For MT-440)

1. Safely secure the vehicle using jack stands.
2. Remove the wheel nuts (1).
3. Remove the wheel (2).
4. Remove the brake drum (3).
5. Clean brake dust with water.
6. Inspect the lining wear of the drum brake system (4).
   - Replace the shoes and springs if the lining thickness is 1/16 in (2 mm) or less.

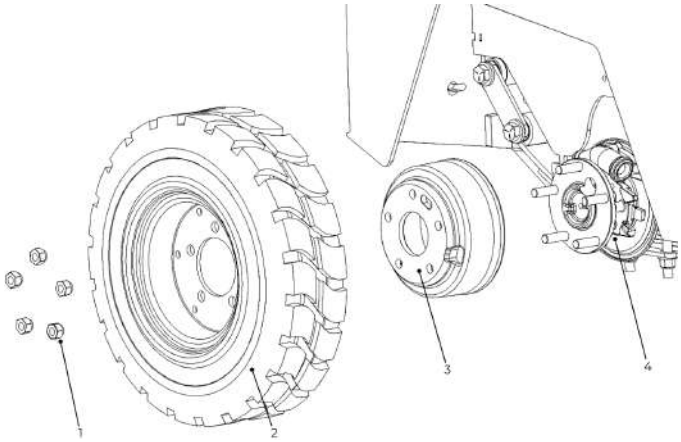


Figure 75. Drum Brakes Inspection.

7. Turn the brake adjustment to reduce the clearance between the lining and drum.
8. Fully seat the brake drum (3) in position.
9. Engage the electromagnetic brake's service knobs to free the wheel axle (if applicable).
10. Spin the brake drum (3) to validate that the shoes aren't overly tightened. The wheels must turn free when the brake pedal is released.
11. Reinstall the wheels (2).
12. Torque the wheel nuts (1) to standard values. The appropriate torque value is 80 ft lbs.

Drum Brakes Replacement (For MT-440N)

1. Chock the front wheels.
2. Remove the wheel nuts (1) and wheel (2).

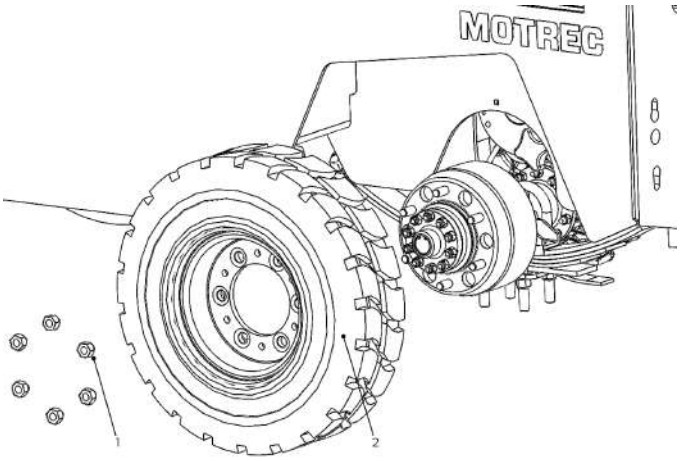


Figure 76. Rear Wheel Removal.

3. Remove the 10 bolts (3).
4. Remove the axle hub cap (4).
5. Remove the brake drum (5).
6. Clean brake dust with water.

Figure 77. Bolts, Axle Hub Cap and Brake Drum Removal.

7. Inspect the lining wear of the drum brake system.
   - Replace the shoes (6) and springs (7) if the lining thickness is less than 1mm.

Figure 78. Shoes and Springs Inspection.

8. Fully seat the brake drum (6) in position.
9. Spin the brake drum (6) to validate that the shoes aren't overly tightened. The wheels must turn free when the brake pedal is released.
10. Reassemble all components in the reverse sequence.

NOTE 1 : Tighten the ring nut (6) to 103 ft·lbf to seat the bearings (11), then loosen the ring nut (6) by unscrewing one full turn.

NOTE 2 : Regarding the wheel nuts (1), tighten them to the specified standard torque value of 80 ft lbs.

4.3.4 REAR AXLE

Procedures

Rear Axle Removal (For MT-440)

Ensure that the vehicle is properly supported on jack stands or that the wheels are chocked to prevent any accidental movement.

NOTE : In order for the rear wheel bearings to be inspected/replaced, the differential oil must be drained to prevent oil leakage.

1. Remove the wheel nuts (1).
2. Remove the wheel (2).
3. Remove the drum brake (3).
4. Clean brake dust with water.

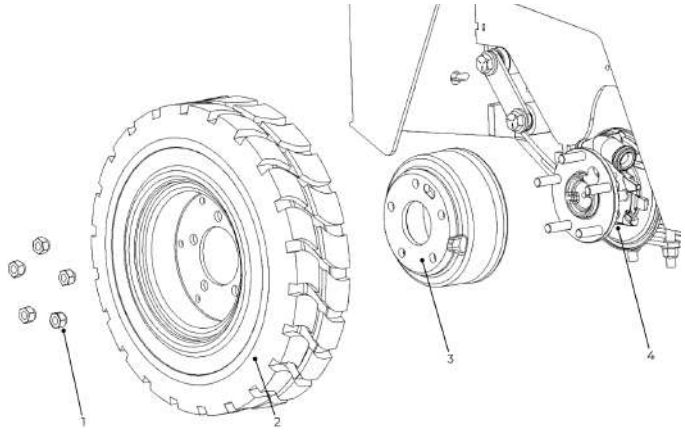


Figure 79. Wheel and Drum Brake Removal.

5. Using a container to collect any leaked fluid, disconnect the hydraulic tube from the drum brake system (4).
6. Remove the backplate mounting screws (5) and their washers from the drum brake system (4).

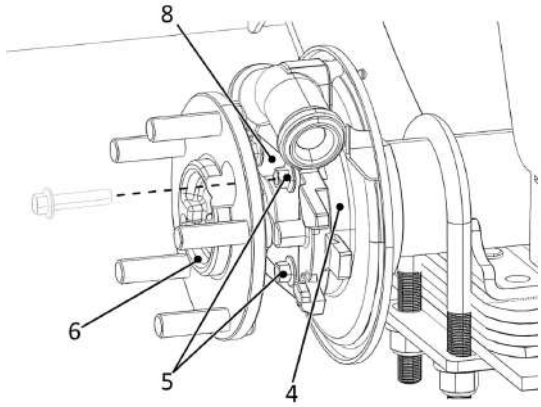


Figure 80. Rear Axle Screws (1 of 2).

7. Remove the axle shaft (6) with the brake drum brake system (4) from the differential's cast-iron case (7).

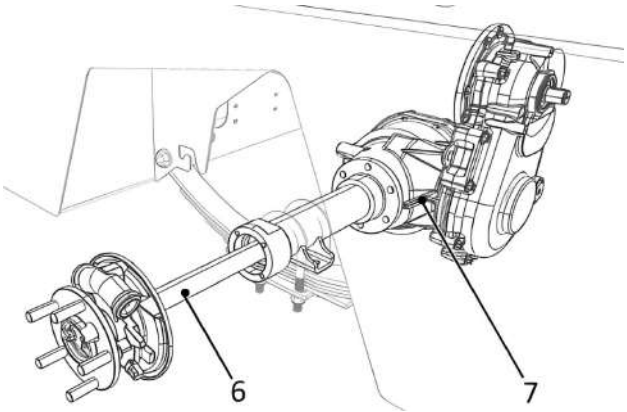


Figure 81. Rear Axle Removal (2 of 2).

8. Inspect the seal (8). Replace if required.
9. Inspect the wheel bearing (9) and its races for wear.
10. Clean and add bearing grease if required.

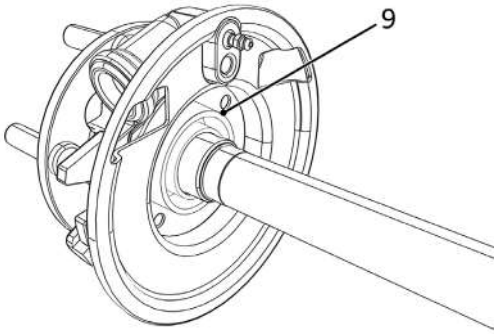


Figure 82. Wheel Bearing.

11. Reinstall the drum brake system (4) and the axle shaft (6) in the differential (7).
12. Reinstall the backplate mounting screws (5) and their washers on the drum brake system (4).
13. Torque the four backplate mounting screws (5) to the recommended standard torque of 58 ft lbs.
14. Reinstall the brake drum (3), wheel (2), and wheel nuts (1).
15. Torque the wheel nuts (1) to the recommended standard torque of 80 ft lbs.
16. Reinstall the hydraulic tube on the brake system.
17. Bleed the brake system as per section **4.3.2 HYDRAULIC BRAKES** subsection *Brake Pedal Bleeding*.
18. Validate that the differential oil level is adequate (it should reach the bottom of the filler hole). For more details, refer to section **4.3.5 DIFFERENTIAL** subsection *Oil Change* page 56.

Rear Axle Removal (For MT-440N)

NOTE : Ensure that the vehicle is properly supported on jack stands or that the wheels are chocked to prevent any accidental movement.

1. Remove the wheel nuts (1) and wheel (2).

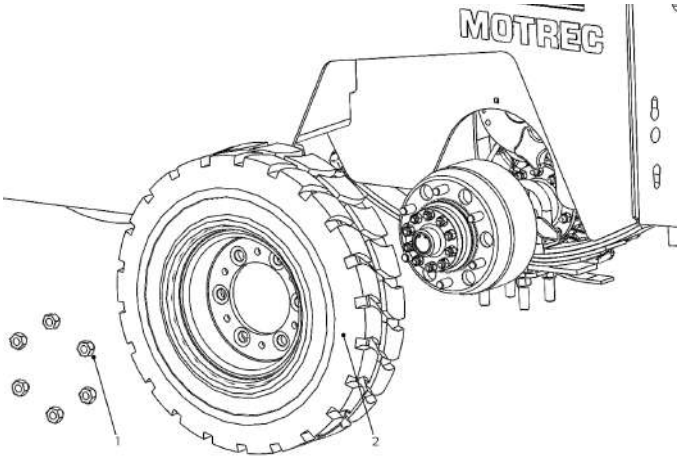


Figure 83. Rear Wheel Removal.

2. Drain the differential fluid (if necessary). Keep a suitable container to catch the fluid and dispose of it properly.
3. Remove the 10 bolts (3).
4. Remove the axle hub cap (4).

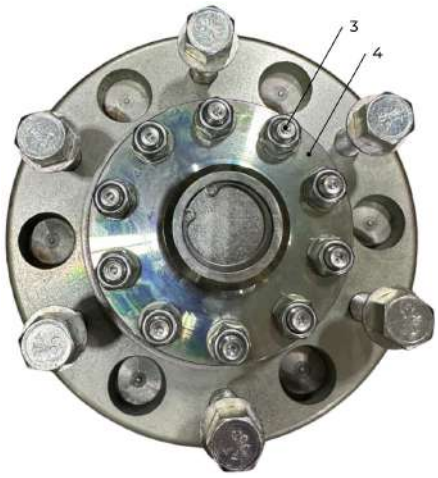


Figure 84. Bolts and Axle Hub Cap Removal.

5. Remove the retaining circlip (6) that holds the bearings. Use the appropriate tool, such as snap ring pliers, to remove it. Carefully slide the clip out to release the axle shaft (5).
6. Remove gently the axle shaft (5) straight out, being cautious not to damage the seals or surrounding components.

Figure 85. Rear Axle Shaft Removal.

Figure 86. Circlip Removal.

7. Inspect it for any signs of damage or wear. If necessary, replace the axle shaft, seals, or any other components that show signs of deterioration.
8. Slide the axle shaft (8) back into the differential (9), aligning it with the splines.
9. Reinstall the retaining circlip (7) to secure bearings in place. Ensure that the clip is properly seated and holds the axle shaft (8) securely.
10. Reassemble all components in the reverse sequence.

    NOTE : Regarding the wheel nuts (1), tighten them to the specified standard torque value of 80 ft lbs.

11. Validate that the differential oil level is adequate (it should reach the bottom of the filler hole). For more details, refer to section **.3.5 DIFFERENTIAL** subsection *Oil Change* page 56.

4.3.5 FRONT AXLE AND STEERING

Procedures

Toe-In Adjustment

1. With the wheels in straight forward direction, measure the inside (left to right) distance between the front tires, at the front and rear of the tires.
2. Adjust by turning the tie rod connecting both wheels until the distances are equal and tighten the two lock nuts on the tie rod.

4.3.5 DIFFERENTIAL

Inspection

1. Look for leaks around:
   - Covers.
   - At axle ends.
   - Casing mating surfaces.
   - Drain/fill plugs.
2. Look for signs of external damage cracks, deformed parts, signs of impacts.
3. Inspect for excessive looseness in internal gears by gently rocking wheels.
4. Drain and inspect oil for excessive shavings/ debris. (If removing cover, perform visual inspection).
5. Inspect suspension mounting (U bolts, shocks, leaf springs, etc.).
6. Test drive: listen for abnormal noise, feel for excess play, **test while turning** as well.

Procedures

Oil Change

The MT-440 and MT-440N are equipped with 2 different differential :

A. The Schafer Twin-Case differential for the MT-440, which includes :
   - The aluminum case.
   - The cast-iron case.

Recommended oil : SAE 80W90 GL5.

NOTE : To perform an oil replacement for the Benevelli differential, follow the procedures outlined in section **4.2.5 EVERY 1000 HOURS OR 12 MONTHS MAINTENANCE** subsection titled "**Schafer Twin-case Differential Maintenance**" page 46.

B. The Benevelli differential for the MT-440N.

Recommended oil : Mobil Mobilube 1 SHC 75W-90 oil (0.5 L).

NOTE : To perform an oil replacement for the Benevelli differential, follow the procedures outlined in section **4.2.5 EVERY 1000 HOURS OR 12 MONTHS MAINTENANCE** subsection titled "**Benevelli Differential Maintenance**" page 47.

4.4 TROUBLESHOOTING

PMC Self-Diagnostic Errors

Active fault codes will be displayed on the display to ease troubleshooting. The PMC also comes with a status LED, which gives a flashing code to help troubleshooting.

Reading fault codes should be your first step in diagnosing any issue.

For a list of all the fault codes, refer to section 5 ANNEXES at the end of this document.

Battery Voltage

WARNING

DO NOT MANIPULATE ELECTRICAL CONNECTIONS OR GENERATE SPARKS AROUND BATTERIES. SPARKS CAN CAUSE A BATTERY EXPLOSION AND ACID SPLASHING. DURING MAINTENANCE, ALWAYS USE INSULATED TOOLS THAT DO NOT GENERATE SPARKS. FAILURE TO COMPLY CAN CAUSE SERIOUS INJURIES.

WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

Some troubleshooting steps require to measure the voltage that the reaches the inspected components. The total battery voltage might be required for these inspections. Make sure batteries are securely connected and measure the voltage between the main fuse terminal (**B+**) and the AC motor controller's (**B-**) terminal for full battery voltage.

4.4.1 ACCESSORIES

Accessories Not Working

1. Turn the key to the ON position.
2. Measure voltage across DC/DC converter input terminals.

   2. 1. Check for the presence of voltage between the positive terminal (**B+**) (White Wire) and the negative terminal (**B-**) (Black Wire) of the DC/DC converter (As shown in Figure 87).

   - If no voltage is present, it is necessary to inspect both the fuse and the wiring.

   2. 2. Check for the presence of voltage between the orange wire and the negative terminal (**B-**) (Black Wire) of the DC/DC converter (As shown in Figure 87).

   - If there is no voltage detected despite the key being ON, it is advisable to examine the wiring.

3. Measure voltage across DC/DC converter output terminals.

   3. 1. Check for the presence of voltage between the yellow/red wire and the green wire of the DC/DC converter (As shown in Figure 87).

   - If not between 11.8V and 14.2V, it indicates a defective converter that requires replacement.

4. Depress the accessory switch, measure voltage across accessory terminals.

- If the measured voltage is not between 11.8V and 14.2V, it indicates a problem with the switch, and it should be replaced.
- If the measured voltage is approximately 12V, it suggests a fault with the accessory itself, and it should be replaced.

NOTE : Ensure accurate voltage measurements by doing the voltage drop test between the switch's terminals, ensure that the voltage measurement registers 0 V. Alternatively, consider the voltage drop when measuring between the accessory's terminals.

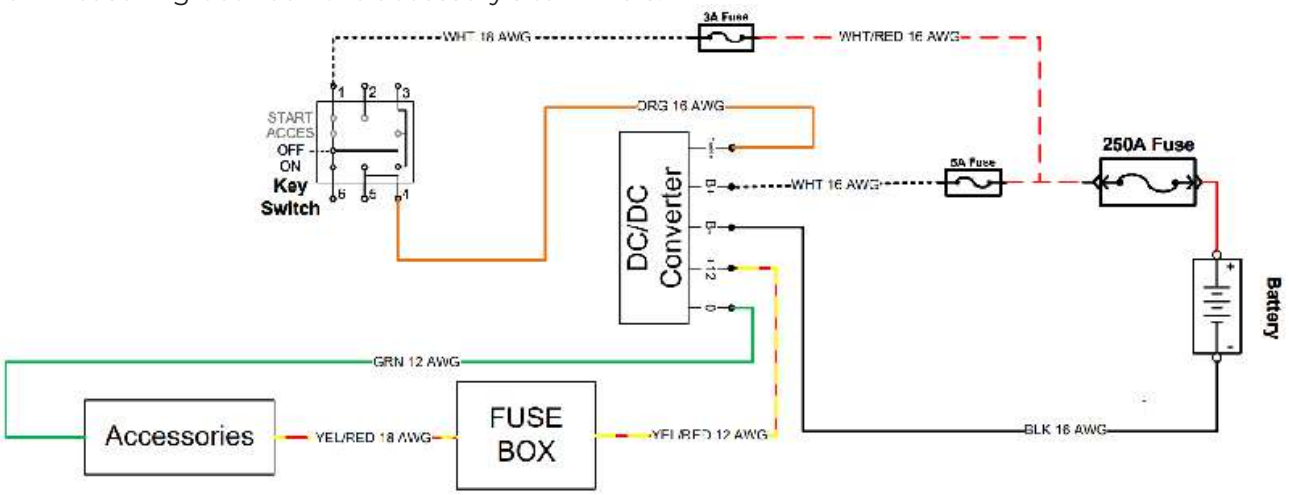


Figure 87. DC/DC Converter Input and Output Terminals Inspection.

4.4.3 VEHICLE MOTION

Vehicle Does Not Move

1. Perform an inspection to detect any fault codes

Please refer to Section 5 Annexes for the meaning/significance of the codes.

2. Inspect the Accelerator Pedal

To verify the proper functioning of the accelerator pedal, follow these steps to check the percentage of throttle by accessing the throttle command in the display:

i. Turn the ignition key to the ON position.

ii. Hold the ENTER button for 5 seconds.

iii. Select MOTREC SETTINGS.

iv. Select INPUT PASSWORD (3050).

v. Select PROGRAMMER.

vi. Select MONITOR.

vii. Select INPUT.

By following these steps, you can monitor the variation of the throttle percentage on the display while stepping on the pedal. This allows you to assess the functionality of the accelerator pedal and ensure it is operating correctly.

3. Inspect the Electromagnetic Brake.

Before troubleshooting the EMB, validate that the non-moving vehicle issue is caused by the electromagnetic brake by screwing in the service knobs, therefore disengaging the electromagnetic brake.

3. 1. Electromagnetic brake not releasing (vehicle doesn't move).

- Excessive air gap (over 0.030 in).
- No current to electromagnetic brake.

⚠ WARNING

PLEASE PAY ATTENTION TO THE VOLTAGE VALUE INDICATED BY THE VOLTMETER. THE VOLTMETER MAY NOT ACCURATELY DISPLAY THE REAL VOLTAGE; INSTEAD, IT MIGHT SHOW A HIGHER VALUE (E.G., 48V) RATHER THAN THE AVERAGE VALUE (E.G., 24V) DUE TO THE IMPLEMENTATION OF PULSE WIDTH MODULATION (PWM).

- Damaged wiring.
- Defective magnet.
- Mechanically stuck pressure plate.

3. 2. Electromagnetic brake dragging (burnt smell / lack of power).

- Low current to electromagnetic brake.
- Defective magnet (partial release).
- Mechanically stuck pressure plate or debris in electromagnetic brake.
- Gripping of rotor hub splines.

3. 3. Electromagnetic brake not engaging.

NOTE: This symptom is sometimes the result of the operator regularly using the Emergency Stop button while the vehicle is still in motion. This wears off the thin friction material on the rotor. Such practice should be avoided.

- Service knobs installed.
- Damaged / broken rotor.
- Mechanically stuck open pressure plate.
- Damaged transaxle internal component.

4. Inspect the Vehicle

1. Make sure that the PMC surface is clean and dry:
   i. Inspect the terminal areas. Dust particles or acid contamination can create current leaks and cause a PMC malfunction.

5. Inspect the Main Contactor

5.1 Verify the presence of voltage at the positive terminal (**B+**) of the contactor.

- If not, check for any fuse or wiring issues.

5.2 Verify the output of voltage from the contactor to the negative terminal (**B-**) of the controller.

- If that's not the case, even if the contactor coil is energized (meaning it is receiving power), it is necessary to replace the contactor.

5.3 Check the voltage between the black/orange wire and the orange/black wire of the contactor.

- If no voltage is detected, it is necessary to inspect the wiring and the output wires of the controller.

Vehicle Moves Forward Only

1. Place the switch in the reverse position.
2. Measure the reverse signal input between pin 33 (Grey/White Wire) on the controller and the negative terminal (**B-**) (Black Wire).
   - If no voltage is detected, proceed to check the voltage at pin 5 of the switch. If there is still no voltage detected, it is necessary to inspect the wiring leading to the key switch.
3. Check for the presence of voltage at pin 4 of the Forward/Reverse switch (Gray/Blue Wire).
   - If no voltage is detected, replace the direction switch.

Vehicle Moves Backward Only

1. Place the switch in the forward position.
2. Measure the reverse signal input between pin 22 (Green/White Wire) on the controller and the negative terminal (**B-**) (Black Wire).
   - If no voltage is detected, proceed to check the voltage at pin 5 of the switch. If there is still no voltage detected, it is necessary to inspect the wiring leading to the key switch.
3. Check for the presence of voltage at pin 6 of the Forward/Reverse switch (green/blue wire).
   - If no voltage is detected, replace the direction switch.

Vehicle Travels at Reduced Speed

⚠ WARNING

WHEN WORKING AROUND BATTERIES, ALWAYS WEAR ACID PROOF PROTECTIVE EQUIPMENT, SUCH AS FACE SHIELD AND THE APPROPRIATE GLOVES. BATTERIES CONTAIN SULFUR ACID THAT CAN CAUSE SEVERE BURNS ON SKIN OR EYES. RINCE CONTAMINATED AREA IMMEDIATELY WITH WATER.

NOTE: Certain faults could cause the vehicle to travel at reduced speeds. The maintenance timer reaching its limit could also cause reduced speeds.

1. Inspect the specific gravity of each battery cell. Cold batteries, highly discharged batteries, or dead cells are the most frequent causes of reduced travel speed.
2. Inspect the potentiometer (of the main pedal) while monitoring the Throttle command on the display.

Other causes of lower speed:

a. Dragging brakes.

b. Cold temperature (effects batteries performance).

c. Turtle Mode ON.

d. Check for the following fault codes: 17, 22, 28, 29, and 54.

Intermittent Movements During Operation

A bad potentiometer is the most probable cause of the following:

- Irregular acceleration.
- Erratic maximum speed.
- Sudden stop after a bump or shock.
- Erratic starts, requiring several pedal cycles.

Erratic starts could also be the cause of a misadjusted potentiometer or microswitch. Monitor this value in the monitoring values section of the display troubleshooting function.

The PMC (Power Management Controller) incorporates two safety features (HPD and SRO). The HPD feature prevents the vehicle from moving if the accelerator pedal is depressed prior to turning on the key switch and activating the seat switch (Presence detection pedal). The SRO feature prevents the vehicle from moving if the direction switch is activated before the presence signal is sent to the PMC. These safety measures ensure that the vehicle remains stationary until the necessary conditions are met, promoting safe operation.

The PMC also has an SRO safety feature that temporarily keeps the vehicle in the OFF state when the key is turned ON. This brief moment of keeping the vehicle off allows for a safety check before enabling movement.

By placing the direction switch in the neutral position and subsequently selecting forward or reverse, the SRO feature ensures that the vehicle can move in the desired direction. This sequential process helps prevent sudden or unintended vehicle movements and allows for a controlled activation of the vehicle's motion.

The vehicle stops on a steep and long ramp or while towing a heavy load: the PMC monitors the temperature of the motor and is also equipped with an internal thermal protection that cuts back the current until the PMC and/or motor has cooled down, furthermore, an error code 28 is displayed (Refer to Section 5 Annexes for a complete list of all codes).

Fault Code List and Diagnostic

8

DIAGNOSTICS AND TROUBLESHOOTING

These controllers detect a wide variety of faults or error conditions. Faults can be detected by the operating system or by the VCL code. This section describes the faults detected by the operating system.

Faults detected by VCL code (faults 51–67 in Table 5) cannot be defined here as they will vary from application to application. Refer to the appropriate OEM documentation for information on these faults.

DIAGNOSTICS

Diagnostics information can be obtained in either of two ways: (1) by reading the display on a 1311 programmer or (2) by observing the fault codes issued by the Status LEDs. See Table 4 for a summary of LED display formats.

The 1311 programmer will display all faults that are currently set as well as a history of the faults that have been set since the history log was last cleared. The 1311 displays the faults by name.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes displaying all the currently set faults in a repeating cycle. Each code consists of two digits. The red LED flashes once to indicate that the first digit of the code will follow; the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow; the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Fault menu of the 1311 programmer, the words **Undervoltage Cutback** will be displayed; the real-time battery voltage is displayed in the Monitor menu ("Keyswitch Voltage").

The controller's two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
*	* *	* *	* * *
(first digit)	(2)	(second digit)	(3)

The numerical codes used by the yellow LED are listed in the troubleshooting chart (Table 5), which also lists possible fault causes and describes the conditions that set and clear each fault.

Summary of LED display formats

The two LEDs have four different display modes, indicating the type of information they are providing.

Table 4 TYPES OF LED DISPLAY

DISPLAY	STATUS
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

TROUBLESHOOTING

The troubleshooting chart, Table 5, provides the following information on all the controller faults:

- fault code
- fault name as displayed on the programmer's LCD
- the effect of the fault
- possible causes of the fault
- fault *set* conditions
- fault *clear* conditions.

Whenever a fault is encountered and no wiring or vehicle fault can be found, shut off KSI and turn it back on to see if the fault clears. If it does not, shut off KSI and remove the 35-pin connector. Check the connector for corrosion or damage, clean it if necessary, and re-insert it.

Table 5 TROUBLESHOOTING CHART

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	Controller Overcurrent *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	1. External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective.	*Set:* Phase current exceeded the current measurement limit. *Clear:* Cycle KSI.
13	Current Sensor Fault *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 2. Controller defective.	*Set:* Controller current sensors have invalid offset reading. *Clear:* Cycle KSI.
14	Precharge Failed *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	2. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging. 1. See Monitor menu » Battery: Capacitor Voltage.	*Set:* Precharge failed to charge the capacitor bank to the KSI voltage. *Clear:* Cycle Interlock input or use VCL function *Precharge()*.
15	Controller Severe Undertemp *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment.	*Set:* Heatsink temperature below -40°C. *Clear:* Bring heatsink temperature above -40°C, and cycle interlock or KSI.
16	Controller Severe Overtemp *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle. 4. Improper mounting of controller.	*Set:* Heatsink temperature above +95°C. *Clear:* Bring heatsink temperature below +95°C, and cycle interlock or KSI.
17	Severe Undervoltage *Reduced drive torque.*	1. Battery Menu parameters are misadjusted. 2. Non-controller system drain on battery. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. See Monitor menu » Battery: Capacitor Voltage. 6. Blown B+ fuse or main contactor did not close.	*Set:* Capacitor bank voltage dropped below the Severe Undervoltage limit (see page 55) with FET bridge enabled. *Clear:* Bring capacitor voltage above Severe Undervoltage limit.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
18	Severe Overvoltage *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.*	1. See Monitor menu » Battery: Capacitor Voltage. 2. Battery menu parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking.	*Set:* Capacitor bank voltage exceeded the Severe Overvoltage limit (see page 55) with FET bridge enabled. *Clear:* Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
22	Controller Overtemp Cutback *Reduced drive and brake torque.*	1. See Monitor menu » Controller: Temperature. 2. Controller is performance-limited at this temperature. 3. Controller is operating in an extreme environment. 4. Excessive load on vehicle. 5. Improper mounting of controller.	*Set:* Heatsink temperature exceeded 85°C. *Clear:* Bring heatsink temperature below 85°C.
23	Undervoltage Cutback *Reduced drive torque.*	1. Normal operation. Fault shows that the batteries need recharging. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Non-controller system drain on battery. 4. Battery resistance too high. 5. Battery disconnected while driving. 6. See Monitor menu » Battery: Capacitor Voltage. 7. Blown B+ fuse or main contactor did not close.	*Set:* Capacitor bank voltage dropped below the Undervoltage limit (see page 55) with the FET bridge enabled. *Clear:* Bring capacitor voltage above the Undervoltage limit.
24	Overvoltage Cutback *Reduced brake torque.*	1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking. 5. See Monitor menu » Battery: Capacitor Voltage.	*Set:* Capacitor bank voltage exceeded the Overvoltage limit (see page 55) with the FET bridge enabled. *Clear:* Bring capacitor voltage below the Overvoltage limit.
25	+5V Supply Failure *None, unless a fault action is programmed in VCL.*	1. External load impedance on the +5V supply (pin 26) is too low. 2. See Monitor menu » outputs: 5 Volts and Ext Supply Current.	*Set:* +5V supply (pin 26) outside the +5V±10% range. *Clear:* Bring voltage within range.
26	Digital Out 6 Overcurrent *Digital Output 6 driver will not turn on.*	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	*Set:* Digital Output 6 (pin 19) current exceeded 15 mA. *Clear:* Remedy the overcurrent cause and use the VCL function *Set_DigOut()* to turn the driver on again.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
27	Digital Out 7 Overcurrent *Digital Output 7 driver will not turn on.*	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	*Set:* Digital Output 7 (pin 20) current exceeded 15 mA. *Clear:* Remedy the overcurrent cause and use the VCL function *Set_DigOut()* to turn the driver on again.
28	Motor Temp Hot Cutback *Reduced drive torque.*	1. Motor temperature is at or above the programmed Temperature Hot setting, and the requested current is being cut back. 2. Motor Temperature Control Menu parameters are mis-tuned. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	*Set:* Motor temperature is at or above the Temperature Hot parameter setting. *Clear:* Bring the motor temperature within range.
29	Motor Temp Sensor Fault *MaxSpeed reduced (LOS, Limited Operating Strategy), and motor temperature cutback disabled.*	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2.	*Set:* Motor thermistor input (pin 8) is at the voltage rail (0 or 10V). *Clear:* Bring the motor thermistor input voltage within range.
31	Coil1 Driver Open/Short *ShutdownDriver1.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. *Clear:* Correct open or short, and cycle driver.
31	Main Open/Short *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. *Clear:* Correct open or short, and cycle driver
32	Coil2 Driver Open/Short *ShutdownDriver2.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. *Clear:* Correct open or short, and cycle driver.
32	EMBrake Open/Short *ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type >0. *Clear:* Correct open or short, and cycle driver.
33	Coil3 Driver Open/Short *ShutdownDriver3.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 3 (pin 4) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
34	Coil4 Driver Open/Short *ShutdownDriver4.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 4 (pin 3) is either open or shorted. *Clear:* Correct open or short, and cycle driver.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
35	PD Open/Short *ShutdownPD.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Proportional driver (pin 2) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
36	Encoder Fault *ShutdownEMBrake.*	1. Motor encoder failure. 2. Bad crimps or faulty wiring. 3. See Monitor menu » Motor: Motor RPM.	*Set:* Motor encoder phase failure detected. *Clear:* Cycle KSI.
37	Motor Open *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPtemp.*	1. Motor phase is open. 2. Bad crimps or faulty wiring.	*Set:* Motor phase U, V, or W detected open. *Clear:* Cycle KSI.
38	Main Contactor Welded *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPtemp.*	1. Main contactor tips are welded closed. 2. Motor phase U or V is disconnected or open. 3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).	*Set:* Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. *Clear:* Cycle KSI
39	Main Contactor Did Not Close *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPtemp.*	1. Main contactor did not close. 2. Main contactor tips are oxidized, burned, or not making good contact. 3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. 4. Blown B+ fuse.	*Set:* With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. *Clear:* Cycle KSI.
41	Throttle Wiper High *ShutdownThrottle.*	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too high.	*Set:* Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring throttle pot wiper voltage below the fault threshold.
42	Throttle Wiper Low *ShutdownThrottle.*	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too low.	*Set:* Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring throttle pot wiper voltage above the fault threshold.
43	Pot2 Wiper High *FullBrake.*	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too high.	*Set:* Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring Pot2 wiper voltage below the fault threshold.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
44	Pot2 Wiper Low *FullBrake.*	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too low.	*Set:* Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring Pot2 wiper voltage above the fault threshold.
45	Pot Low Overcurrent *ShutdownThrottle;* *FullBrake.*	1. See Monitor menu » Outputs: Pot Low. 2. Combined pot resistance connected to pot low is too low.	*Set:* Pot low (pin 18) current exceeds 10mA. *Clear:* Clear pot low overcurrent condition and cycle KSI.
46	EEPROM Failure *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake;* *ShutdownPump.*	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into the controller.	*Set:* Controller operating system tried to write to EEPROM memory and failed. *Clear:* Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	HPD/Sequencing Fault *ShutdownThrottle.*	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu » Inputs.	*Set:* HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. *Clear:* Reapply inputs in correct sequence.
47	Emer Rev HPD *ShutdownThrottle;* *ShutdownEMBrake.*	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	*Set:* At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral. *Clear:* If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.
49	Parameter Change Fault *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	*Set:* Adjustment of a parameter setting that requires cycling of KSI. *Clear:* Cycle KSI.
51–67	OEM Faults *(See OEM documentation.)*	1. These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.	*Set:* See OEM documentation. *Clear:* See OEM documentation.

OEM CODE
CODE 51 Can Initialization: Check PIN 23 (twisted wire green and yellow)
CODE 52 Can Operational : Check PIN 23 (twisted wire green and yellow)
CODE 53 Foot pedal or Switch Fault : Check PIN 24 / Throttle Accelerator Signal
CODE 54 Maintenance is required
CODE 55 Throttle active before foward
CODE 56 Throttle active before reverse
CODE 57 FWD and REV active : Bad switch FWD / REV
CODE 58 Driver voltage exceeded : Max voltage for driver is 24V
CODE 62 HPD / SRO Sequence fault : incorrect starting sequence

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
68	VCL Run Time Error *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump.*	1. VCL code encountered a runtime VCL error. 2. See Monitor menu » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	*Set:* Runtime VCL code error condition. *Clear:* Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
69	External Supply Out of Range *None, unless a fault action is programmed in VCL.*	1. External load on the 5V and 12V supplies draws either too much or too little current. 2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. 3. See Monitor menu » Outputs: Ext Supply Current.	*Set:* The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. The two thresholds are defined by the External Supply Max and External Supply Min parameter settings (page 52). *Clear:* Bring the external supply current within range.
71	OS General *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump.*	1. Internal controller fault.	*Set:* Internal controller fault detected. *Clear:* Cycle KSI.
72	PDO Timeout *ShutdownInterlock; CAN NMT State set to Pre-operational.*	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	*Set:* Time between CAN PDO messages received exceeded the PDO Timeout Period. *Clear:* Cycle KSI or receive CAN NMT message.
73	Stall Detected *ShutdownEMBrake; Control Mode changed to LOS (Limited Operating Strategy).*	1. Stalled motor. 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Problems with power supply for the motor encoder. 5. See Monitor menu » Motor: Motor RPM.	*Set:* No motor encoder movement detected. *Clear:* Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
87	Motor Characterization Fault *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrotsle;* *FullBrake;* *ShutdownPump.*	1. Motor characterization failed during characterization process. See Monitor menu ▫ Controller: Motor Characterization Error for cause: 0▫none 1▫encoder signal seen, but step size not determined; set Encoder Step Size manually 2▫motor temp sensor fault 3▫motor temp hot cutback fault 4▫ controller overtemp cutback fault 5▫controller undertemp cutback fault 6▫undervoltage cutback fault 7▫severe overvoltage fault 8▫encoder signal not seen, or one or both channels missing 9▫motor parameters out of characterization range.	*Set:* Motor characterization failed during the motor characterization process. *Clear:* Correct fault; cycle KSI.
89	Motor Type Fault *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrotsle;* *FullBrake;* *ShutdownPump.*	1. The Motor_Type parameter value is out of range.	*Set:* Motor_Type parameter is set to an illegal value. *Clear:* Set Motor_Type to correct value and cycle KSI.
91	VCL/OS Mismatch *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrotsle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake;* *ShutdownPump.*	1. The VCL software in the controller does not match the OS software in the controller.	*Set:* VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. *Clear:* Download the correct VCL and OS software into the controller.
92	EM Brake Failed to Set *ShutdownEMBrake;* *ShutdownThrottle.*	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	*Set:* After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. *Clear:* Activate the throttle.
93	Encoder LOS (Limited Operating Strategy) *Enter LOS control mode.*	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detect Fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	*Set:* Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. *Clear:* Cycle KSI, or if LOS mode was activated by the Stall Fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.

Table 5 TROUBLESHOOTING CHART, continued

CODE	PROGRAMMER LCD DISPLAY / EFFECT OF FAULT	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
94	Emer Rev Timeout *ShutdownEMBrake;* *ShutdownThrottle.*	1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. 2. The emergency reverse input is stuck On.	*Set:* Emergency Reverse was activated and ran until the EMR Timeout timer expired. *Clear:* Turn the emergency reverse input Off.
98	Illegal Model Number *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;* *ShutdownPump.*	1. Model_Number variable contains illegal value (not 1234, 1236, 1238, or 1298). 2. Software and hardware do not match. 3. Controller defective.	*Set:* Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_Number, and a fault is issued if one is not found. *Clear:* Download appropriate software for your controller model.

9 MAINTENANCE

There are no user serviceable parts in Curtis 1234/36/38 controllers. **No attempt should be made to open, repair, or otherwise modify the controller.** Doing so may damage the controller and will void the warranty.

It is recommended that the controller and connections be kept clean and dry and that the controller's fault history file be checked and cleared periodically.

CLEANING

Periodically cleaning the controller exterior will help protect it against corrosion and possible electrical control problems created by dirt, grime, and chemicals that are part of the operating environment and that normally exist in battery powered systems.

CAUTION

When working around any battery powered system, proper safety precautions should be taken. These include, but are not limited to: proper training, wearing eye protection, and avoiding loose clothing and jewelry.

Use the following cleaning procedure for routine maintenance. Never use a high pressure washer to clean the controller.

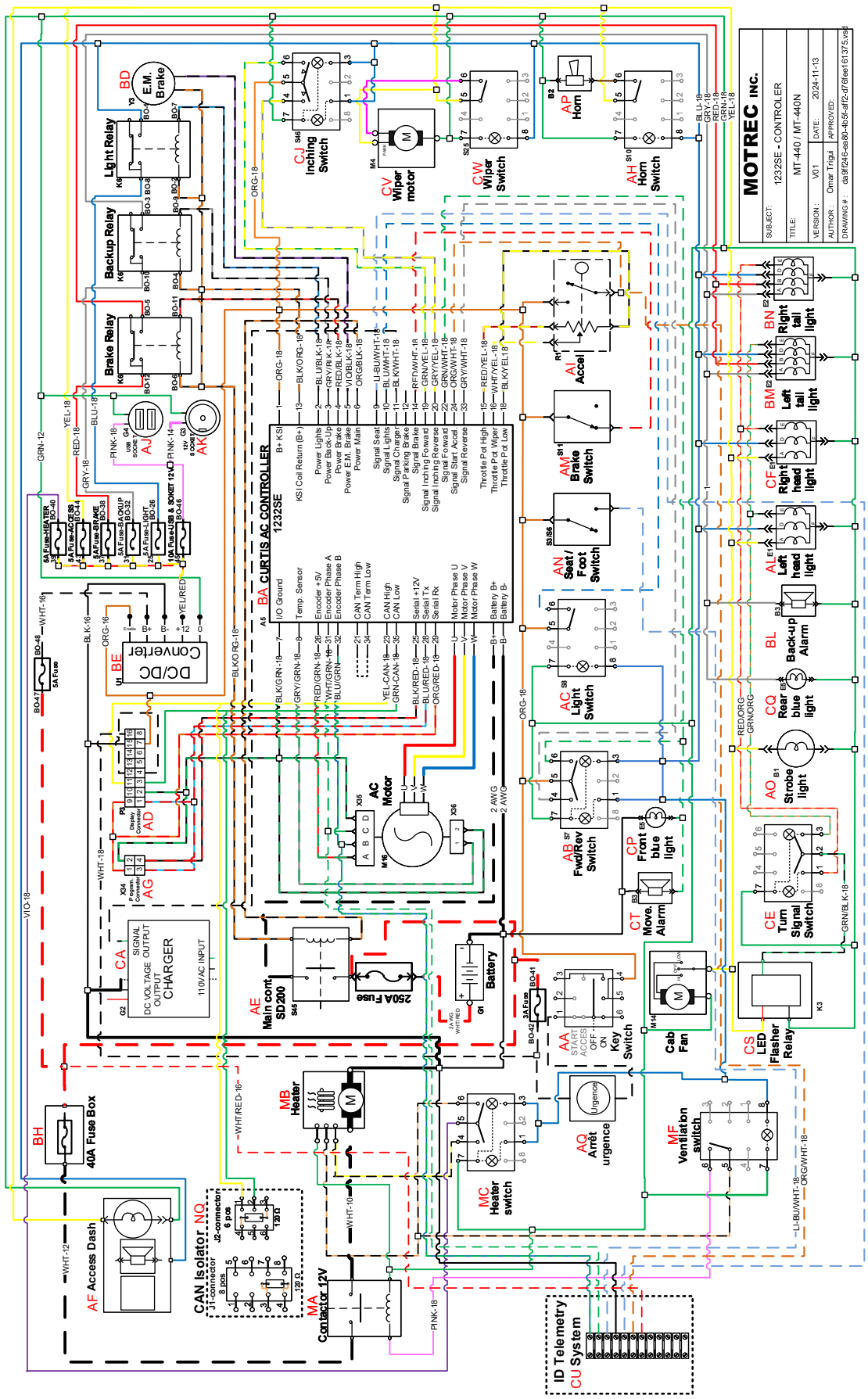
1. Remove power by disconnecting the battery.
2. Discharge the capacitors in the controller by connecting a load (such as a contactor coil) across the controller's **B+** and **B-** terminals.
3. Remove any dirt or corrosion from the power and signal connector areas. The controller should be wiped clean with a moist rag. Dry it before reconnecting the battery.
4. Make sure the connections are tight. Refer to Section 2, page 5, for maximum tightening torque specifications for the battery and motor connections.

FAULT HISTORY

The 1311 programmer can be used to access the controller's fault history file. The programmer will read out all the faults the controller has experienced since the last time the fault history file was cleared. Faults such as contactor faults may be the result of loose wires; contactor wiring should be carefully checked. Faults such as overtemperature may be caused by operator habits or by overloading.

After a problem has been diagnosed and corrected, it is a good idea to clear the fault history file. This allows the controller to accumulate a new file of faults. By checking the new fault history file at a later date, you can readily determine whether the problem was indeed fixed.

Electrical Diagram



Standard Torque

BOLT CLAMP LOADS

Suggested Assembly Torque Values

	USS/SAE GRADE 5					USS/SAE GRADE 8				
DIAMETER & THREADS PER INCH	TENSILE STRENGTH MIN. PSI	PROOF LOAD LB	CLAMP LOAD LB	TORQUE DRY FT LB	LUBRICATED FT LB	TENSILE STRENGTH MIN. PSI	PROOF LOAD LB	CLAMP LOAD LB	TORQUE DRY FT LB	LUBRICATED FT LB
1/4-20	120,000	2,700	2,020	8	6.3	150,000	3,800	2,850	12	9
28	120,000	3,100	2,320	10	7.2	150,000	4,350	3,250	14	10
5/16-18	120,000	4,450	3,340	17	13	150,000	6,300	4,700	24	18
24	120,000	4,900	3,700	19	14	150,000	6,950	5,200	27	20
3/8-16	120,000	6,600	4,950	30	23	150,000	9,300	6,980	45	35
24	120,000	7,450	5,600	35	25	150,000	10,500	7,900	50	35
7/16-14	120,000	9,050	6,780	50	35	150,000	12,800	9,550	70	50
20	120,000	10,100	7,570	55	40	150,000	14,200	10,650	80	60
1/2-13	120,000	12,100	9,050	75	55	150,000	17,000	12,750	110	80
20	120,000	13,600	10,200	85	65	150,000	19,200	14,400	120	90
9/16-12	120,000	15,500	11,600	110	80	150,000	21,800	16,350	150	110
18	120,000	17,300	12,950	120	90	150,000	24,400	18,250	170	130
5/8-11	120,000	19,200	14,400	150	110	150,000	27,100	20,350	210	160
18	120,000	21,800	16,350	170	130	150,000	30,700	23,000	240	180
3/4-10	120,000	28,400	21,300	260	200	150,000	40,100	30,100	380	280
16	120,000	31,700	23,780	300	220	150,000	44,800	33,500	420	310
7/8-9	120,000	39,300	29,450	430	320	150,000	55,400	41,600	600	450
14	120,000	43,300	32,450	470	350	150,000	61,100	45,800	670	500
1-8	120,000	51,500	38,600	640	480	150,000	72,700	54,500	910	680
14	120,000	57,700	43,300	720	540	150,000	81,500	61,100	1,020	760

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